

DISSEMINATION BY STATE SCIENCE SUPERVISORS OF A CD-ROM DISC
FOR INNOVATION IN CURRICULUM PLANNING

By

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Abstract of Dissertation Presented to the Graduate School
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This study identified activities conducted by 35 state science supervisors to disseminate Science Helper, a Compact Disc with Read Only Memory, CD-ROM. The investigation also explored why the supervisors disseminated this innovation, the first application of CD-ROM technology to science education.

Four research questions were addressed: (a) What dissemination activities did state science supervisors conduct? (b) How did workplace environment and role definition influence their actions? (c) What demographic and professional characteristics of the supervisors affected their actions? (d) What characteristics of Science Helper influenced the supervisors to disseminate it?

Science supervisors were interviewed 13 to 21 months after they were trained to use the disc. Interviews were the primary data for this study. Other

sources of data included conversations, electronic communications, and correspondence.

Thirty supervisors invested time and money to acquire CD-ROM readers to operate Science Helper. Many of them had to surmount bureaucratic and technical difficulties to acquire and set up CD-ROM equipment.

Eighty-three percent of the supervisors conducted dissemination activities. All new supervisors and most supervisors with 18 or more years of experience disseminated the innovation. A disproportionate number of supervisors with 8–17 years experience were in the least active group of supervisors.

Supervisors reported 268 dissemination activities consisting of 12 types of activities and involving 14 types of clients. The most common activities were providing information about Science Helper or demonstrating it at conventions or workshops. The most frequent clients were district science supervisors and teachers.

The strongest influence on the supervisors' actions was Science Helper's curricular features. Supervisors valued Science Helper's lessons, praised its search system for finding relevant lessons, and found Science Helper's features to be compatible with their beliefs about curriculum. Supervisors with the most positive perceptions of Science Helper's curricular possibilities conducted the most dissemination activities.

General conclusions were that state science supervisors can be energetic change agents when they perceive the innovation to have advantages, and dissemination of the innovation is consistent with their role as curriculum providers.

The supervisors perceived Science Helper to be a valuable curricular tool providing new capabilities for lesson planning.

CHAPTER I INTRODUCTION

Rationale for the Study

Heightened federal attention is being focused on the improvement of science education. Leaders in both the executive and legislative branches of government have had a growing interest in science education reform since the release of Nation at Risk (National Commission on Excellence in Education, 1983). The President of the United States has recently added to the momentum of searching for strategies to improve science education. In the President's America 2000 initiative, improved science education is mentioned in two of six goals advanced for education reform (U.S. Department of Education, 1991). He also has directed cabinet members to identify and strengthen science education programs in their departments. For its part, the United States Congress has dramatically increased funding for science education in the National Science Foundation and the Department of Education.

Because such attention is on science education reform it is prudent for the science education community and policy leaders in the government to consider every avenue that may contribute to improvement. This study aids that task by examining state science supervisors' dissemination of an innovation, the first application of CD-ROM technology to lesson planning, and investigating supervisors' perceptions of the innovation that influenced them to disseminate it.

State science supervisors are a seldom explored route for dissemination of innovations. The dissemination of innovations is an important aspect of any national strategy to implement innovations in science education. Routes for spreading innovations need to be found, and state science supervisors are rarely considered even though they are change agents who have potentially influential positions.

State science supervisors are employees of state departments of education with responsibilities to support and monitor science education in the school districts in their states. The state science supervisors' efforts to promote changes have a notable impact in their states, and those efforts also have national impact when taken cumulatively. State science supervisors can also act collectively to encourage national changes in science education. Only two previously reported studies have examined state science supervisors (Dowling & Yager, 1983; Trueblood, Szabo, & Nippes, 1979).

A second focus of this study is the first application of a new technology to science education. This innovation, Science Helper, is a Compact Disc with Read-Only Memory, CD-ROM, on which approximately 17,000 pages of science lessons are stored. The disc makes possible a mode of curriculum planning that has not been feasible in the past, namely, rapid access to multiple lessons that could serve a user-selected purpose.

A third focus of this study is to produce further understanding of dissemination, namely, the dissemination activities of the state science supervisors in relation to the new CD-ROM technology and the Science Helper disc. Few

researchers studying the dissemination of innovations have explored in detail the determinants of dissemination of a specific innovation. Data were collected to examine the determinants of the state science supervisors' actions (i.e., why they disseminated Science Helper).

A substantial federal investment was made in research on change during the early 1980s resulting in large-scale studies (Berman & McLaughlin, 1978; Crandall, 1982). Since then, few national resources have been committed to further understanding of the change process in more recent contexts. The renewed emphasis on science education is resulting in new innovations. It would be helpful to learn more about the factors that influence dissemination of a technological product in science education.

Findings from this study can assist policymakers as attempt to to improve science education in three ways. First, the study illuminates the dissemination activities of state science supervisors, influential change agents at the state level about whom little is known. Second, the study yields information about factors that affected the extent and kind of dissemination activities in which state science supervisors engaged. Third, the features of Science Helper and CD-ROM technology that related to the functions of state science supervisors and their clients' needs were also examined.

Prior to this study, state science supervisors received hands-on training in the use of Science Helper. The 35 supervisors in this study attended a 3-day workshop funded by the National Science Foundation and held at the University of Florida in September 1988. They learned to use Science Helper, discussed possible

dissemination strategies to carry out in their home states, and took home a copy of the disc.

Statement of the Problem

The purpose of this study was to determine what actions were taken by state science supervisors to disseminate Science Helper and to identify the determinants of those actions: In the broadest terms, the questions were, what did the subjects do subsequent to training and why did they do it? Specifically, this study was designed to address the following research questions:

1. What activities were carried out by state science supervisors to disseminate Science Helper to their clients?
2. What facets of their organizational environment and role influenced their actions?
3. What demographic and professional characteristics of the supervisors affected their actions?
4. What characteristics of Science Helper influenced the supervisors' dissemination of it?

Delimitations

Only the 35 state science supervisors who were trained in the use of Science Helper took part in this study. Thirty-five supervisors from different states attended a 3-day workshop at the University of Florida in September 1988, during which they received hands-on experience with Science Helper. This training was the first exposure to Science Helper and CD-ROM technology for all but two of the participants. Supervisors who did not attend the workshop were not included in

the study because it was unlikely that they had knowledge of Science Helper or disseminated it. The 35 supervisors in this study represent approximately 70% of all state science supervisors.

Limitations

Findings from this study about the numbers of supervisors' activities must be taken as conservative estimates. Participants were asked general questions and had to recall their activities when responding. It is likely that supervisors conducted more activities than they reported since they undoubtedly failed to recall some of them.

Description of Science Helper

An innovation is any change being introduced to an individual or group (Hall & Hord, 1987, p. 9). These changes can be processes or tangible things. Examples of innovations are a holistic reading program introduced to a school faculty, questioning techniques introduced to a single teacher, or stress-coping strategies recommended to district administrators.

The innovative characteristics of Science Helper can be understood by contrasting its use with traditional curricular resources. An educator who wants to obtain a lesson plan for a hands-on science or mathematics activity ideally would consult student science texts, teacher reference books, or colleagues. The reality is that many schools do not have science texts at lower grade levels, have few references books on hand, and the professional ethos at most schools discourages teacher communication. Even if individuals do have access to a wealth of

resources, it still will be difficult to find lesson plans that match students' interests, abilities, and curricular needs.

Low, Carson, and Zlotolow commented that "an obvious way to share instructional strategies would be to set up an electronic database into which teachers could submit descriptions (of lessons), and from which teachers could draw and modify suggestions of colleagues" (1988, p. 31). Apparently, Low et al. were not aware of Science Helper, a database of 1,000 lesson plans for 2,000 hands-on activities in science and mathematics for grades kindergarten through eight.

Not only do Science Helper users have access to the equivalent of 88 books of lessons, they also are provided with a search program that allows them to select appropriate lessons. Users may choose any or all of the following lesson criteria as shown in Figure 1: grade, subject (physical science), science process (controlling variables), content theme (statistical view of nature), or topic (plant). After selecting lesson criteria, the user may view both abstracts of the resulting lessons or the lessons in a matter of seconds. An example of a lesson abstract is provided in Figure 2. The option exists for users to print both lesson abstracts and lessons.

Thus, Science Helper provides a library of lesson plans and a search program to help users link their goals and needs to appropriate lessons. It has been described in educational trade journals (Phillipo, 1989; Rowe, 1991; Salpeter, 1988; Tanner & Bane, 1988) and reviewed as well (Jenkins, Brewer, Spooner, Kousen, & Thiess, 1990).

<u>Grades</u>	<u>Science Processes</u>
Preschool	Applying/Problem Solving
Kindergarten	Classifying
Grade 1	Operationally Defining
Grade 2	Experimenting
Grade 3	Communication
Grade 4	Interpreting Data
Grade 5	Modeling
Grade 6	Measuring
Grade 7	Inferring
Grade 8	Observing/Recording
	Predicting
	Using Math/Equations
	Controlling Variables
	Hypothesizing
<u>Subjects</u>	<u>Vocabulary Words/Phrases</u>
Astronomy/Space Science	(Listed alphabetically from a to z)
Botany	absorption
Chemistry	acceleration
Engineering	accuracy
Physical Science	acid/base
General Science	addition
Human Science	adhesion
Earth Science	advertising
Life Science	air
Mathematics/Statistics	air pressure
Physics	air resistance
Ecology/Environment	algae
Zoology	algebra
	alka-seltzer
	...
	...
	etc.
<u>Content Themes</u>	
Interaction/Change	
Energy	
Instruments	
Structure of Matter	
Patterns in Nature	
Space/Time Relationships	
Statistical View of Nature	

Figure 1. Search options in Science Helper. (User may choose any combination of criteria. Multiple selections may be made within a category and their logical relation can be specified as "and" or "or".)

LESSON TITLE (Abstract): The Compass and Electromagnetic Fields

LESSON TITLE (Source): The Compass

BOOK TITLE: Batteries and Bulbs: Circuits/Magnets

PROGRAM NAME: ESS

DESIGNATED GRADE LEVEL: 4-6

RATED GRADE LEVEL: 3-6

STARTING PAGE: 003

ENDING PAGE: 009

SUBJECT: Physical Science, Physics, Chemistry

PROCESS THEME: Experimenting

CONTENT THEME: Systems, Energy

KEYWORDS: electricity, electromagnetic field, magnetism, compass

Children use common objects and supplies to investigate the use of a compass to detect electromagnetic fields.

Figure 2. Example of an lesson abstract in Science Helper. After entering selection criteria, users are given lesson abstracts like the one above. Abstracts are used to determine which lesson(s) best address users situation and curricular needs.

Science Helper makes use of a new technology known as Compact Disc-Read Only Memory, CD-ROM. These discs are optical discs that utilize the same technology as the popular compact discs. The CD-ROM technology permits the storage of 200,000 typed pages on a 3.5 inch disc. Readers desiring further understanding of the technical and operational features of CD-ROM technology are referred to Luhn, Byers, and McManus (1987), Tiampo (1987), or Bardes (1986).

Disc developers usually put a search program on the disc that allows users to find information that matches their needs. In the case of Science Helper, it takes

only seconds for users to enter lesson requirements and obtain the corresponding lesson plans.

Rapid and selective information retrieval is possible because CD-ROM discs run in a CD-ROM reader (alternately called a CD-ROM player) that is connected to a computer. These CD-ROM readers are beginning to appear in numerous educational niches such as school libraries, classrooms, and district offices.

Description of State Science Supervisors

Virtually all states and territories have one or more employees in their departments of education who support their government's efforts in science education. These state science supervisors are the interface between the department of education and the science supervisors and/or teachers in the state's school districts. The number and roles of state science supervisors vary from state to state. A populous state could have several supervisors with specialized responsibilities for elementary, middle, or high school science. Less populated states may only have a supervisor with general curriculum responsibilities.

State science supervisors have a complex job with many functions. This study focuses on one of their major job functions: State science supervisors consult with district science supervisors, administrators, and teachers on curriculum in science education. State science supervisors, however, have many other functions such as assisting in the preparation of legislation and auditing school districts' programs in science education.

Definition of Terms

A case study is an empirical inquiry that investigates a contemporary phenomenon in its real-life context is referred to as a case study.

A Compact Disc-Read Only Memory (CD-ROM) is an optical disc storing up to 550 megabytes of information that can rapidly and selectively be retrieved. Discs are operated in a CD-ROM reader (or player), a device that attaches to a computer.

A district science supervisor is an employee of a local school district with supervisory responsibilities for science education in the district's schools. This term includes supervisors based at the district office as well as supervisors that are school-based.

Science Helper is a CD-ROM disc containing 1,000 lesson plans for hands-on science activities appropriate for grades kindergarten through eight. The full commercial name of this disc is Science Helper K-8.

A state science supervisor is an employee of a state department of education who supports and monitors science education throughout the state. The term supervisors will refer to state science supervisors rather than district science supervisors when used in this study.

Organization of the Study

The remainder of this dissertation has been organized into four chapters. A review of related literature on the role of state science supervisors, the use of CD-ROM in education, and the dissemination of educational innovations constitutes Chapter II. The research perspective, case study methodology, the sample, and the

collection and analysis of data are discussed in Chapter III. The results and discussion are presented in Chapter IV. A summary, conclusions, implications, and recommendations for further research appear in Chapter V.

CHAPTER II REVIEW OF LITERATURE

The focus of this investigation was the dissemination of Science Helper by state science supervisors. Studies from three areas of literature were reviewed to provide perspective for the study: (a) the role of science supervisors, (b) the use of CD-ROM in education, and (c) the dissemination of educational innovations. It is notable that a search of the literature yielded only two reports of research on the first topic, no reports of research on the second topic, and few investigations on the last topic that had a focus similar to the one in this study.

Role of Science Supervisors

The literature was reviewed for studies on both state science supervisors and district science supervisors. Madrazo and Hounshell (1987) described the status of research in science supervision: "Little attention has been given to science supervision in the science education literature, even though the science supervisor is a very important person in the science education enterprise. . . . In general, the literature on science supervision can be considered meager." (p. 9)

Although the participants in this study were state science supervisors, it was relevant to note some findings from the literature on district science supervisors because most state science supervisors must function at times as district science supervisors. Small school districts typically do not have a district science

supervisor. Teachers and administrators in these small districts often turn to the science supervisor at the state department of education when needs arise that require expertise in science instruction.

State Science Supervisors

Studies of the state science supervisors are reported in this section of the chapter. A brief description and definition of state science supervisors were given in the introductory chapter. A thorough review of the literature located only two studies in the last 10 years that reported data about state science supervisors.

Trueblood, Szabo, and Nippes (1981) surveyed state mathematics supervisors and state science supervisors about the status of implementation of metric education, and 66 supervisors from 42 states responded. Some insight was gained about the role of state science supervisors even though the researchers' questions did not directly probe supervisors' roles. The researchers' conclusion most relevant to this dissertation was "State supervisors developed and located materials for inservice teacher training as well as curriculum guides and classroom instructional materials" (p. 15). Thus, state supervisors in the late 1970s reported that they supplied curricular materials to their clients.

Dowling and Yager (1983) collected information from state science supervisors about their professional background and the bureaucratic status of their job positions. Participants were asked to report their years of experience as state science supervisors. Supervisors from 40 states responded. The same kinds of data were collected in this dissertation to investigate whether the supervisors' job experience influenced their dissemination of Science Helper.

Dowling and Yager also specified job functions and asked supervisors to report the percentages of time that they spent on each. The job function most germane to this dissertation was "local consultation," to which supervisors reported that they gave 28% of their time. Thus, the state science supervisors responding in this study and the study by Trueblood et al. reported that they provided curriculum assistance to their clients as part of their job.

District Science Supervisors

Ritz (1988) briefly summarized the findings of the dozen or so studies reported in the literature over the last 15 years that investigated the role of district science supervisors. The following discussion highlights findings from these studies that pertain to district science supervisors.

The Association of Supervision and Curriculum Development, ASCD, established a task force to investigate roles of district science supervisors. Costa and Guditus (1984) reported that the task force surveyed the data already available. This survey included a search of ERIC data, and solicitation of information from each state's Chief School Officer. A couple of comments are noteworthy:

This effort revealed that objective data on the role and importance of district-wide science supervisors are largely unavailable. . . . We discovered that there is no system in effect for collecting data about effectiveness and influence of supervisors. Their roles, expectancies, and job descriptions are often vague. (p. 84)

The task force went on to suggest questions and topics for further study: "What are curriculum and instructional supervisory functions? . . . Studies need to be performed of how supervisory systems operate" (p. 85).

Madrazo and Motz (1982) reported that the National Science Teachers Association's (NSTA) Committee on the Supervision of Science Teaching conducted a survey to investigate the role of district science supervisors. The survey asked teachers and administrators to list role functions of the district science supervisor and to rank these functions in the order that would most closely fit their needs as clients.

Madrazo and Motz identified seven categories of functions from the responses and listed them in order of importance as ranked by the respondents. The most highly ranked function was to assist in development of classroom "instructional materials." The category that was ranked second was curriculum consultation. This function was described in part as the communication of significant new developments. The national survey conducted by Madrazo and Motz only had a sample of 210, and the researchers considered the survey to be exploratory work.

Madrazo and Hounshell (1987) studied the role of district science supervisors in North Carolina. Using the Science Coordinator's Role Expectations Questionnaire developed by Ortiz (1977), they surveyed 595 educators who were superintendents, supervisors, teachers, principals, and professors in colleges of education. This instrument consists of 48 Likert-type questions that asked whether respondents agreed with various role descriptions of the district science supervisor.

Questions were grouped into five subscales. The subscale most relevant to this discussion is "the supervisor as a resource in science teaching." Respondents had stronger agreement with this description of the supervisor role than they did

with statements in any other subscale. Further, all the types of respondents listed above agreed strongly with this role description of district science supervisors.

Thus, the studies of district science supervisors showed that district supervisors perceived themselves to be resources in science teaching and communicators of significant new curriculum developments. Responses from the clients of district science supervisors agreed considerably with those of the district science supervisors.

Use of CD-ROM in Education

A brief description and definition of Compact Discs–Read Only Memory, CD-ROM discs, is found in Chapter I. The following discussion is drawn from articles about the use of CD-ROM and Science Helper in education published in educational magazines and journals. However, this dissertation is the first empirical study conducted on any aspect of the dissemination or use of CD-ROM in education or science education.

CD-ROM discs have only been available in the public sector for the last 6 years, their original use being in the military. Businesses and libraries have been the major users of CD-ROM in the public sector thus far. Libraries are also the most common niche for CD-ROM in education to date.

General Potential of CD-ROM in Education

Compact discs with educational applications began to appear 4 years ago. The ERIC disc (Morabito, 1987) and Grolier Encyclopedia were early examples. Now there are several encyclopedias on CD-ROM, and the most recent have more operational features than earlier discs (Becker, 1991).

CD-ROM is rapidly emerging in education. Teacher education courses about the use of technology in education have begun to include CD-ROM (Shore, Mason, Pederson, & Armstrong, 1990). Parisi and Jones (1988) found enough CD-ROM resources for education to compile them for a reference book. Mendrinos (1990) noted: "CD-ROM is quietly but steadily making inroads into the school library media center, where it satisfies information needs across the curriculum. . . . The possible uses of CD-ROM technology in school offices, classrooms, and library media centers are endless" (p. 36). Several other articles have appeared that include discussions of the potential uses of CD-ROM in education (Bitter, 1988; Everhart, 1988; Hiscox & Hiscox, 1986; McGinty, 1988; Miller, 1987; O'Connor, 1986). British educators also have published articles on the educational uses of CD-ROM (Frogbrook, 1988; Megarry, 1988).

Science Helper for Curriculum Planning

Science Helper is the first CD-ROM disc designed specifically for use in science education. It was described briefly in Chapter I and has also been described in several educational sources (Phillipo, 1989; Salpeter, 1988; Tanner & Bane, 1988). Mendrinos (1990) lists Science Helper as one of the most popular CD-ROM discs in education. Several users of Science Helper gave their appraisal of it in a recent article (Jenkins et al., 1990).

Science Helper is an important innovation in science education because it is the first CD-ROM disc in the field, and is designed to fulfill tasks that are not addressed by other CD-ROM discs in education. Most discs are huge resources of reference information, encyclopedias on CD-ROM being prime examples. The

purpose of Science Helper is to assist educators in curriculum planning. The large amount of information stored on Science Helper is lesson plans rather than reference information typically found in a library. Science Helper not only contains this compilation of lessons, it also has a search system for finding appropriate lessons in that database. This search system is designed to teach a strategy for thinking about planning lessons.

Dissemination of Educational Innovations

This study focused on how and why the state science supervisors spread knowledge about Science Helper to their clients. The common term for the spread of knowledge is dissemination; the phrase most often used in the literature to refer to dissemination is the diffusion of innovations. These terms are used interchangeably in this study. Studies on the diffusion of innovations in education are discussed in this section as well as some literature on the implementation of innovations that was found to be relevant to the dissemination of Science Helper.

Research on the dissemination of innovations began at the turn of the century and grew into a large body of knowledge spanning diverse research fields. The most recent exhaustive compilation and analysis of studies on the diffusion of innovations was done by Rogers in 1983. He reported 3,085 investigations, 336 in education. Rogers concluded that two factors affect the diffusion of innovations: (a) the characteristics of the people adopting the innovation, and (b) the characteristics of the innovation as they are perceived by adopters.

Characteristics of Adopters

Over half of the studies were investigations of the characteristics of adopters of innovations. Fullan and Pomfret (1977) reviewed 14 studies on the implementation of curriculum and instruction and found the characteristics of educators to be an important influence on their acceptance of the innovations. They identified various demographic factors (e.g., sex, age) and aspects of the organizational climate (e.g., support from colleagues and superiors) that characterized adopters. The sex, age, and organizational climate of the state science supervisors were examined for their influence on the dissemination of Science Helper. The job experience of state science supervisors was also examined (i.e., their number of years of experience as state science supervisors).

Perceived Characteristics of Innovations

Only 1% of dissemination studies have investigated the effect of subjects' perceptions of innovations on their dissemination of it. Rogers (1983), a preeminent scholar in dissemination research, criticized the lack of investigations into perceived characteristics of innovations:

One may be impressed with how little effort has been devoted to analyzing innovation differences, i.e., in investigating how the properties of an innovation affect its rate of adoption. . . . Diffusion researchers in the past tended to regard all innovations as equivalent units for study and analysis. This is an oversimplification, and a dangerous one. That all innovations are not equivalent units is evidenced by the fact that some new products fail and others succeed. (p. 210–211)

Findings from the few studies in education that have examined subjects' perceptions of innovations are briefly described below. The participants in these studies were

principals and teachers; the participants in this dissertation study were state science supervisors.

In his 1983 review, Rogers defined five major perceived characteristics of innovations as follows: Relative advantage is the degree to which an innovation is perceived as being better than the idea or thing it supersedes (p. 213); compatibility is the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters (p. 223); complexity is the degree to which an innovation is perceived as relatively difficult to understand and use (p. 230); trialability is the degree to which an innovation may be experimented with on a limited basis; and observability is the degree to which the results of an innovation are visible to others (p. 232).

Holloway (1977) investigated the perceptions that 100 principals held of educational innovations. He factor-analyzed their responses to Likert-type items and identified five perceived attributes of the innovations that were influential in dissemination: relative advantage, compatibility, complexity, trialability, and observability. Several years earlier, Clinton (1973) and Hahn (1974) factor-analyzed teachers' responses to innovations and identified attributes of the innovation that were similar to those found by Holloway.

More recently, Dozier (1985) examined the diffusion of 12 electronic innovations among university students and faculty. He found the same five attributes identified in the earlier studies to be useful in explaining different rates of acceptance for the 12 innovations.

From his review of the literature on perceived innovation characteristics, obtained from studies in all disciplines, Rogers (1983) concluded that the "strongest support is generally found for the attribute dimensions of relative advantage, compatibility, and complexity, with somewhat weaker support for the existence of trialability and observability" (p. 212). All of these attributes had a positive influence on dissemination with the exception of perceived complexity, which had a negative influence on dissemination.

The effects of the state science supervisors' perceptions of the characteristics of Science Helper on their dissemination of it were investigated in this study. The five attributes discussed above were examined for their usefulness in describing the participants' actions and perceptions.

Summary

The literature was reviewed in the following areas pertaining to this study: (a) the role of science supervisors, (b) use of CD-ROM technology in education, and (c) dissemination of educational innovations. The following conclusions were drawn from studies found in the literature review: (a) the very limited data collected to date indicate that science supervisors provide curriculum resources to their clients and consider this an important part of their job; (b) Science Helper, an innovation for curriculum planning, is the first application of CD-ROM technology in science education; (c) two factors that influence the acceptance of innovations are the characteristics of the adopters and their perceptions of the innovation's characteristics; and (d) several investigators have identified five perceived

characteristics of innovations that affect their dissemination (relative advantage, compatibility, complexity, trialability, observability).

CHAPTER III DESIGN OF THE STUDY

The Research Perspective

In studying the state science supervisors to find out what dissemination activities they conducted with Science Helper and why they took those actions, it was useful to approach the supervisors with a qualitative perspective. Asking them general questions about their actions and perceptions prompted them to describe their experiences extensively. The supervisors revealed actions and perceptions that had not been foreseen by the researcher.

This unanticipated data would not have been obtained with questionnaires that only asked questions about aspects of their actions and perceptions that could be thought of a priori by the investigator. There was little research in the literature to suggest specific questions to ask: Little is documented about the state science supervisors' role; no investigations have been reported on the introduction of CD-ROM technology to education. Rogers (1983) concluded that questionnaire studies of the dissemination of innovations did not reveal much about subjects' actions and perceptions:

Diffusion scholars should more adequately see an innovation through the eyes of their respondents, including a better understanding of why the innovation was adopted. . . . We should not give up on trying to find out the why of adoption just because valuable data about adoption motivations are

difficult to obtain by the usual methods of diffusion research for data gathering. (p. 99)

Case Study Methodology

This investigation used a case study methodology. Yin (1989) stated that "the case study strategy has a distinct advantage when a 'how' or 'why' question is being asked about a contemporary set of events over which the investigator has little or no control" (p. 20). All of the elements in Yin's statement about when case studies are useful were present in the problem studied in this investigation. The focus was on events that were happening during the investigation (i.e., they were contemporary events). The research questions asked how the state science supervisors were disseminating Science Helper and why they were doing so. The investigator did not have control over the actions of the state science supervisors.

Yin (1989) went on to say that case studies are appropriate for studying events in their real-life context using multiple sources of evidence (p. 23). The purpose of the study was to investigate the supervisors' dissemination of Science Helper in the context of their own states. Multiple sources of data were available to study this situation. Investigations of the dissemination of innovations have employed case study methods in the past (Merriam, 1988, p. 33; Yin, 1989, p. 31).

This study had a single-case design with embedded units of analysis (Yin, 1989, p. 41). The single case in this study was the dissemination of Science Helper by 35 state science supervisors over a 21-month period. This single case had two units of analysis. Generalizations were made about state science supervisors as a group based on their dissemination of Science Helper. However, these conclusions

were drawn by first analyzing the actions and perceptions of individual supervisors. Comparison and compilation of these individual results led to conclusions about the population.

Single-case studies are informative when the case is revelatory. The research problem in this study is revelatory because the phenomenon investigated has rarely occurred. Namely, the state science supervisors seldom meet as a group, especially for the purpose of spending several days to become familiar with a curricular innovation. Thus, the state supervisors' participation in a 3-day training workshop to explore a curricular innovation was a significant event. This study revealed the outcome of the training, the supervisors' dissemination of Science Helper.

Single-case studies can also be considered revelatory when the phenomenon has rarely been accessible for scientific investigation. It is normally difficult to contact state science supervisors to arrange time for interviews because of demands on their schedules that frequently include tasks that take supervisors out of the office. Further, it is expensive to contact state science supervisors because they are located all over the country. The investigator met all the supervisors during training and was therefore in the unusual position of being familiar with them. This enhanced the investigator's access to the supervisors and they made time for interviews and other interactions. Finally, uncommon circumstances enabled the investigator to contact the supervisors. They had their own electronic network, and they permitted the investigator to use it as one means of communicating with them.

Grant funds enabled the investigator to attend three national conventions that many of the subjects also attended.

Reliability

A common definition of reliability is whether a study can be repeated and yield similar results. A standard reliability issue in qualitative studies is the reliability of the principal research instrument (i.e., the investigator). Efforts were made to make this study as reliable as possible: (a) researcher bias was addressed, and (b) the researcher collaborated with other science educators.

The professional qualifications of the researcher that bear on his ability to conduct this investigation are listed below to increase the reader's confidence in the researcher's reliability:

1. The researcher taught science courses in grades 9 through 12 for 4 years, serving as science department chair for the last 3 years.
2. The researcher has extensive experience with the innovation, Science Helper.
3. The researcher is familiar with science education curriculum issues through coursework and 5 years of experience on funded projects in science education.
4. The researcher has taken two courses in qualitative research methodology and theory and a short course on software tools for coding and sorting qualitative data.

Steps were taken to prevent bias of the researcher from influencing the study. Any investigator in dissemination research is vulnerable to what Rogers

(1983) calls a pro-innovation bias. This bias is described as the belief that "an innovation should be diffused and adopted by all members of the system; that it should be diffused more rapidly; it should not be re-invented or rejected" (p. 98). Pro-innovation bias can influence researchers to discount the consideration of whether the innovation is better for a given adopter than the status quo. The investigator addressed this bias in two ways. First, he consistently monitored his attitude and language during data collection and analysis to prevent the bias. Second, he informed the subjects that his position toward the implementation of Science Helper was neutral (i.e., he told the supervisors that they were the best judge of the appropriateness of Science Helper as an innovation for their clients). Language dealing with this was included in the setup for interviews (see appendix).

The researcher sought assistance from committee members, fellow doctoral students, and a state science supervisor to increase the study's reliability. Spradley (1979) advocated the use of an informant in studies where extensive interviews will be conducted. A state science supervisor who was familiar with Science Helper but did not have any responsibility for disseminating it assisted the researcher during the study. The data collected were discussed with these colleagues, suggestions for further research were received, and alternative explanations for findings were proposed.

Validity

The validity of case studies is increased by the collection of multiple types of data that pertain to the same phenomenon. Several data sources were available

for this study: formal interviews, informal conversations, electronic messages, and correspondence.

Collaboration with peers and experts increases the validity of a study as well as its reliability. Several types of people assisted in various aspects of this investigation.

Data were collected over a 21-month period to better understand dissemination as a process. Rogers (1983) reported that "diffusion researchers have mainly relied upon a one-shot survey of their respondents, a methodology that amounts to making the diffusion process almost timeless by its stop-action effect of freezing the action in a continuous process over time" (p. 113).

The Study Sample

The dissemination activities of 35 state science supervisors were studied. State science supervisors were described and defined in Chapter I. All of the supervisors in this study attended a 3-day workshop at the University of Florida where they were trained to use Science Helper and discussed its dissemination. The investigator met the state science supervisors at this workshop, which consequently enhanced his access to them for this study. Because the workshop was the first exposure to Science Helper and CD-ROM for all but two of the supervisors, it was considered unlikely that supervisors not attending the workshop would have any familiarity with the innovation, and they were not included in the study.

Data Collection

Four types of data were obtained in this study: (a) formal interviews, (b) informal conversations, (c) electronic communications, and (d) correspondence. The time periods during which these types of data were collected are given in Figure 3.

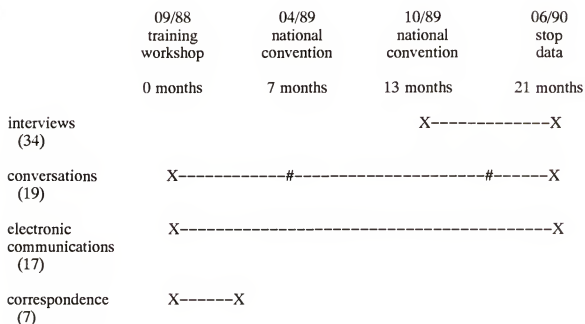


Figure 3. Timelines for collection of data. (Although telephone conversations took place throughout the study, more conversations took place during two conventions indicated with #. Number of supervisors that provided each type of data indicated in parentheses.)

Seven supervisors sent unsolicited letters to the director of the training workshop within the 4 months that followed it. In these letters, provided to the investigator, the state science supervisors gave feedback on the training and their experiences with Science Helper immediately after it. Many supervisors initiated

similar communications with the investigator shortly after their training through telephone calls and electronic communications. Electronic communications and telephone conversations continued throughout the study.

Electronic communications were possible because the state science supervisors had their own electronic network. They permitted the investigator to send and receive messages via this network. Some supervisors also entered information into the network about their experiences and problems with Science Helper that could be read by all the other supervisors as well as the investigator.

The investigator held conversations with many participants at two national conventions. The first convention took place 7 months after the training workshop. On this occasion, 10 of the state science supervisors initiated conversations with the investigator during chance encounters to speak about their perceptions of Science Helper and dissemination of it. Nine other supervisors spoke with the investigator during the second convention, which took place 19 months after the training workshop. The investigator dictated notes about each conversation on a microcassette recorder immediately after it took place.

The correspondence received by the investigator as well as the number of spontaneous conversations and electronic communications initiated by the state science supervisors led the researcher to believe that a phenomenon existed that should be studied. That is, many state science supervisors were disseminating Science Helper.

Interviews were conducted with all the supervisors during a period from 13 to 21 months after their training. These interviews were from 20 to 40 minutes

long. Approximately one third of the supervisors agreed to be individually interviewed while attending a national convention. The investigator scheduled the interviews throughout the convention and held them in a quiet room. Following the convention, the rest of the supervisors were interviewed by telephone over the next 8 months. All interviews were recorded on a microcassette recorder and were transcribed by a professional typist.

The interviews were conducted in a conversational format, but an interview guide was used to ensure that similar questions were asked of each supervisor (appendix). The supervisors were asked four general questions related to the research questions. The researcher used anecdotal notes during the interviews to tag comments and topics to be investigated further in the interview by means of probing questions.

Data Analysis

Suggestions found in several prominent references for qualitative methods, case studies in particular, were incorporated in the study design and data analysis. Merriam (1988) and Yin (1989) provided guidelines for increasing the validity and reliability of case studies, and many of these were used in this investigation. Miles and Huberman (1984) encouraged researchers to conduct quantitative analysis of qualitative data when insight can be provided by doing so. That suggestion was used in this study by counting categories of data and displaying these results in tables in order to efficiently communicate large amounts of qualitative data to the reader (e.g., see Tables 8, 9). Spradley (1979) encouraged researchers to examine

the meaning research participants hold for their own words and this principle guided the investigator during data collection as well as data analysis.

Coding the Data

Glaser and Strauss (1967) and later Glaser (1978) suggest that qualitative data be coded inductively by using what they call the constant comparison method. Several elements of this method were useful for coding the data in this study: (a) Data were examined line by line; (b) categories were established by inspecting the data, and (c) different kinds of comparison were used as analysis progressed.

A single line of data was the smallest unit of data to be coded. Although, many single lines of data did receive their own code(s), coded portions of data ranged in length from a single phrase to several paragraphs depending on the content of the passage. Codes for the data were derived from the context of the study and the research participants' meanings. This procedure contrasts with deductive approaches where codes are established a priori and data are assigned to them. However, the study's questions were used as a conceptual guide when examining the data.

Three kinds of data comparison were used in stages, as recommended in the third element of the constant comparison method of analysis: (a) incident to incident, (b) category to more incidents, and (c) category to category. During the first stage of analysis each datum was compared to many others to draw out commonalities and contrasts. This procedure allowed the investigator to derive preliminary categories, or codes, from the data. The investigator analyzed the complete data record from one supervisor at a time and kept a running list of the

codes that were being established. Entirely new categories often had to be created during analysis of data from each new subject. When a new category was established, the investigator reexamined previously analyzed data to look for similar instances. Also, existing categories were frequently redefined in this early stage by splitting some categories into subcategories and combining other categories into more encompassing categories.

The second kind of analysis, comparing categories to more incidents, was the predominant method at the point where data from about two thirds of the supervisors had been analyzed. The criterion for shifting the emphasis of the procedure at this point was that new pieces of data increasingly fit into previously established categories. All the data that had been coded into each category was thoroughly reviewed to more clearly define the nature of the data in that category. From that point on, previously unexamined data from additional supervisors were carefully compared to the definitions of the established categories to see where they best fit. Definitions of categories were still refined, however, when needed to accommodate the new data. As this kind of comparison was conducted on data from additional supervisors, it became increasingly rare to alter the definitions of the categories of data or to establish new categories. The term coined by Glaser and Strauss (1967) for this situation is theoretical saturation.

Three experts in science education assigned the same codes as the investigator 80% of the time when they examined data that had not been analyzed previously. The investigator asked a committee member and two graduate students in science education to review his categories of data. After the investigator

provided written definitions for all established categories, these individuals as well as the investigator examined an interview with a state science supervisor that had not been analyzed previously. All four experts assigned the same codes to the same data 80% of the time. The other 20% of the time the experts commonly failed to attached multiple codes to the same incident. For example, in an instance where a state science supervisor had demonstrated Science Helper to a group of teachers and district science supervisors, some experts coded the clients as either teachers or district supervisors and neglected to assign the other code as well. The experts seldom assigned conflicting codes due to disagreement over definitions of the categories.

After data from all of the supervisors had been examined, the third and final analysis procedure from the constant comparison method was instituted: categories were compared to categories. That is, the data from each category were compared to that of other categories. During the second stage of comparative analysis each category had evolved into a logically consistent set of data that could be defined. The purpose of comparing categories exhaustively in the third stage was to address hypotheses that pertained to the study questions.

As a result of this stage of analysis the researcher grouped the categories of data into five sets that related to the study's questions: (1) the supervisors' preparations for disseminating Science Helper, (2) the supervisors' dissemination activities, (3) the clients they interacted with during these dissemination activities, (4) the context that the supervisors worked in, and (5) the supervisors' perceptions of Science Helper's features. The fourth set of data referred to above contained

demographic information about the state science supervisors such as sex and age, as well as information about the nature of their jobs and their length of job experience.

Sorting the Data

The majority of the data record, including all interviews and conversations, was transcribed by a professional typist into text files. This made it possible to use Qualpro, a commercial software package, to designate codes for each line of the data (Blackman, 1986). Subsequently, with the help of Qualpro, all data identified by a specific code could be retrieved for analysis.

Summary

The investigator employed a case study methodology to investigate the dissemination of a CD-ROM disc known as Science Helper by 35 state science supervisors. Prior to the study, all subjects had attended a 4-day training workshop where hands-on experience with Science Helper took place.

The case study design was a single case with embedded units of analysis (Yin, 1989). The case was the dissemination of Science Helper by the 35 supervisors, and data were analyzed at two levels: individual subjects and across subjects.

A study of this single case was revelatory in three ways (Yin, 1989): (a) state science supervisors have rarely been given the opportunity and support, as a group, to gain first-hand experience with an innovation so they can be knowledgeable disseminators; (b) both the nature and demands of the state science supervisors' work as well as their geographically diverse locations usually prohibit

researchers from gaining access to them as subjects; (c) Science Helper was the first CD-ROM disc developed for science education.

Case study methodology was appropriate because: (a) the research situation was a real-life development that was already in progress and not amenable to experimental control; (b) multiple sources of data were available; (c) the questions being investigated sought to explain the hows and whys of the supervisors' actions.

Steps were taken to make the study as valid and reliable as possible. The researcher's qualifications and biases are listed in the chapter to help the reader ascertain his reliability as an investigator. Reliability was also established by the involvement of committee members, other graduate students, and a state science supervisor, not involved in dissemination of Science Helper, who assisted the researcher in understanding the words and action of the supervisors (Spradley, 1979). Collaboration with these researchers and science educators helped the investigator adhere to a phenomenological perspective wherein he attempted to understand data from the supervisors using their perspectives. This collaboration also enhanced the study's validity. Another element of the study design that enhanced validity was the collection of multiple sources of data from individual supervisors.

Data were collected over a 21-month span so there would be adequate time to examine the dissemination process. Interviews were the primary data: Secondary data sources were conversations, correspondence, and electronic communications. Conversation-style interviews, conducted with a four-question protocol, were held with every supervisor and lasted from 20 to 40 minutes. The frequency of

secondary data collected varied from one-quarter to one-half of the supervisors. Some conversations and interviews occurred over the telephone, and others took place during conventions, the former happening spontaneously, the latter as planned meetings.

The general approach to data analysis was the constant comparative method (Glaser, 1978; Glaser & Strauss, 1967). Data were transcribed by a professional typist and then inspected line by line. The entire data record of each supervisor was analyzed individually, and then data from different subjects were compared. Early analysis established categories of data, which were further defined by inspection of more data. Categories of data were then compared. Qualpro software was used to assign codes to the data and to sort the data.

Chapter III described the research perspective, case study methodology, including steps to enhance reliability and validity, the study sample, data sources, data collection, and data analysis. Results of the study are presented in Chapter IV.

CHAPTER IV RESULTS OF THE STUDY

The purpose of this study was to determine what actions were taken by state science supervisors to disseminate Science Helper and to identify the determinants of those actions. Data were obtained from the following sources: (a) interviews, (b) conversations, (c) electronic messages, and (d) correspondence.

Scheduled interviews were conducted and taped with all supervisors. Other sources of data were spontaneous and occurred throughout the study with varying proportions of the supervisors. Brief conversations took place between the investigator and over half of the supervisors. Electronic messages were sent by half of them. One fifth of them corresponded in writing.

The findings are presented in three sections. The supervisors' preparations for dissemination are reported in the first section. Section two presents the dissemination activities carried out by state science supervisors for Science Helper. Determinants of their actions are discussed in section three.

Preparation for Dissemination

The first section of this chapter briefly discusses the extensive actions taken by the supervisors to prepare for dissemination of Science Helper. Data on these preparations were collected as one aspect of the first research question of the study: What activities were carried out by state science supervisors to disseminate Science

Helper to their clients? Preparation activities were (a) obtaining CD-ROM players to use Science Helper, and (b) setting up the CD-ROM player and the disc.

Obtaining CD-ROM Players

The data in Table 1 show that a large majority of the subjects, 86% of them, went to the effort and expense of obtaining a CD-ROM player, or access to one, for operating Science Helper. Although all the supervisors were provided with

Table 1

Actions Taken by State Science Supervisors to Obtain CD-ROM Readers

Action	Supervisors	
	Number	%
Took reader home from training workshop	12	34
Acquired and purchased reader at home	14	40
Obtained access to reader	4	11
Obtained CD-ROM readers	30	86

a Science Helper disc to take home from the training workshop, they had to obtain a CD-ROM player, also called a CD-ROM reader, in order to operate it at home. Seventy-four percent of the supervisors committed from \$500 to \$800 of their budgets to purchase readers. All 12 CD-ROM readers made available at the training workshop by Amdek corporation for \$500 were taken home by supervisors.

The rest of the supervisors who elected to purchase their own players had to order them upon returning home. Four supervisors preferred to find access to CD-ROM readers at their home sites rather than purchase one of their own.

Many supervisors who chose to buy a CD-ROM reader had to go through an arduous and protracted process to (a) obtain authorization, or (b) execute their state purchasing procedures. Forty percent of the supervisors commented on these issues. They generally identified the latter as a larger obstacle than the former.

Although some supervisors had the authority to initiate purchase on their own, many others had to obtain authorization to purchase from people at one or more organizational levels above them. This involved educating busy decision-makers about CD-ROM and Science Helper to get consent as described by the following comments from one supervisor:

...All the red tape we had to go through, and I think part of it dealt with some new technology that the department was going to purchase, and no one else in the department had ever bought....So why are you getting? So there was a lot of trying to give the rationale for it and so forth, and even though they wanted me to be down there to get the training, they didn't see the link between that and the use of the thing.

The authorization step required effort and patience to find time for busy people to talk about it. One supervisor had to wait a year for the authorization to purchase from several organizational levels above him. One supervisor reported that explaining the situation to his superior was going to take too much effort and that he did not pursue obtaining a reader for this reason.

State paperwork and processes for purchasing a CD-ROM reader were also difficult to contend with for a variety of reasons. The paperwork bogged down for

several individuals because it was the first time the purchasing staff had ever heard of a CD-ROM reader. This hamstrung several clerical decisions such the equipment code that should go on the paperwork, the justification for purchasing, or the purchasing language that should be used. Some supervisors had to solicit bid prices for CD-ROM readers from several companies because of their state's policies regarding the nature or size of the purchase. In other cases the paperwork took several months even when no conceptual snags developed.

Four supervisors decided to avoid the authorization and purchasing difficulties and instead gained access to the use of existing CD-ROM readers. Two canvassed technology companies in the area until they found firms willing to provide them with units on long-term loan. Another searched through his large department of education until he found a reader. He then bartered for the equipment with supplies in an unofficial swap. One supervisor located a reader for use in the public library.

Setting Up CD-ROM Equipment and Science Helper

Fifty percent of the state science supervisors who went to the effort of obtaining a CD-ROM reader reported having to overcome technical difficulties when setting up a working system to use Science Helper. The technical word for setting up is installation and the three main installation problems that were encountered and dealt with by the supervisors are listed in Table 2: (a) difficulties when installing the CD-ROM reader in a computer, (b) conflict between Science Helper and other programs, and (c) need for additional software to run Science Helper. Further discussion will avoid detailed explanation of these problems and

Table 2

Installation Problems Overcome by State Science Supervisors Who Obtained CD-ROM Readers

Problem	Supervisors	
	number	%
Installation of CD-ROM on computer	9	30
Science Helper conflicts with other programs	4	13
Additional software needed to start	4	13

will focus on the work that supervisors performed to deal with them. The installation problems are identified, however, so that readers with computer experience can better appreciate the nature of the problems. All except one of the state science supervisors who reported problems were persistent and overcame these technical difficulties even though such tasks are not standard for many state science supervisors.

The effort necessary for state science supervisors to solve installation problems depended on the extent of the problem, their familiarity with computers, and the availability of others to help. Several supervisors were able to solicit help from adept computer users in their departments; others had to deal with the issues themselves. One supervisor had two technical problems that made it difficult to diagnose either of them because each problem masked the other's presence. This

supervisor persevered through the confounding problems even though it meant driving 1.5 hours to a repair center.

It was often necessary to work through these problems intermittently (i.e., taking one step and having to wait for further information or materials before being able to take the next). It is difficult for supervisors to see a protracted problem through. The complexity of their positions forces supervisors to attend to diverse and numerous issues that constantly change. The difficulty of monitoring and persisting with a nagging problem was illustrated by one supervisor's comment:

I don't put much time on any one project anyhow, but half an hour is all I can put on anything at a given time. I put my half hour in, and it didn't work so I was able in the next couple of weeks to find another half hour after I got the stuff and got it up and running.

Many of the state science supervisors experiencing set-up problems turned to other state science supervisors for assistance. A dozen communications about problems and solutions appeared on the state science supervisors' electronic network, PSI-NET. Several supervisors posted information on this electronic bulletin board explaining how they had solved their technical difficulties. Others put out messages soliciting assistance. Several supervisors spoke during interviews of calling other supervisors on the telephone to deal with dilemmas in setting-up.

Dissemination Activity

The second section of this chapter presents data that completes consideration of the first research question of the study: What activities were carried out by state science supervisors to disseminate Science Helper to their clients? Data are organized into the following subsections: (a) amount of dissemination activity, (b)

types of clients, (c) types of dissemination activities, (d) pattern between types of clients and types of activities, (e) activities related to dissemination, and (6) descriptions of two supervisors' dissemination activities.

Amount of Dissemination Activity

Most of the state science supervisors in this study disseminated Science Helper, and a total of 268 dissemination events were identified in the data. The most active supervisor reported 44 dissemination activities. The average number of activities for all other supervisors was 7. Although the nature of these events is described in the subsequent subsections, it should be noted here that supervisors employed a wide variety of activities with a diverse set of clients. The design of the study leads to the conclusion that the 268 events noted above is a conservative estimate (i.e., supervisors undoubtedly carried out more events).

The supervisors were grouped in Table 3 by the number of dissemination activities they undertook: Supervisors conducting only 0–2 activities were designated "inactive"; supervisors who carried out 3–9 activities were identified as "active"; and "very active" supervisors carried out 13–44 activities. Using this classification scheme, 83% of the subjects were either active or very active in disseminating Science Helper, with 60% and 23% of the state science supervisors being active and very active, respectively. Six supervisors were considered inactive but only three of them reported no dissemination activity at all.

The criteria for designating levels of dissemination activity were restricted to the numbers of activities conducted without making any distinctions between the kinds of activities. For example, presenting a demonstration at a convention and

Table 3

Inactive, Active, and Very Active State Science Supervisors: Grouped by Number of Dissemination Activities

Subject Group	n	Number of Dissemination Activities	Number of Supervisors Reporting
Inactive Supervisors	6	0	3
		1	1
		2	2
Active Supervisors	20	3	6
		4	4
		5	1
		6	1
		7	4
		8	2
		9	2
Very Active Supervisors	8	13	1
		14	2
		16	1
		17	2
		20	1
		44	1

doing an office demonstration were each counted as one event, though a greater time is typically involved in preparing for and carrying out the former.

The numbers used to differentiate between the inactive, active, and very active supervisors were established on the basis of the total impression of each supervisor gained from the data record of each one. The break in number of activities between 9 and 13 prompted consideration of that as a distinction between supervisors. Comparison of the data records for supervisors in these two groups subsequently indicated that those supervisors designated "very active" went to considerably greater lengths to disseminate than did the "active" supervisors. Although no such clear mathematical discontinuity existed in the numbers of activities separating the "inactive" and "active" groups, a strong difference was found when examining the total record of the different supervisors. The data record of each supervisor designated as "inactive," even of those conducting 1 or 2 activities, confirmed that these supervisors should be characterized as inactive in contrast to the supervisors in the active group.

All state science supervisors in rural states either were in the active or very active groups of supervisors. No generalization could be made about the amount of activity of supervisors in the more urban states. No explanation was found in the data record for the higher activity level of the supervisors in rural states.

Further data about the amount of the supervisors' activity are reported in section three of this chapter, determinants of dissemination. It will be shown that a relationship existed between the amount of the supervisors' activity and their length of job experience.

Types of Clients

State science supervisors interacted with 14 types of clients listed in Table 4 in their efforts to disseminate Science Helper. Descriptions of these client types are presented in Table 5. The state supervisors interacted most often with teachers and district science supervisors: Two thirds of the supervisors conducted dissemination activities with teachers, and half of the supervisors interacted with district science supervisors. The number of dissemination activities involving either of these groups is four times greater than the number of activities involving any other type of client.

Between 10 and 30% of the supervisors interacted with eight of the client types other than teachers and district supervisors. In the cases of the four types of clients that were least frequently contacted, only a single supervisor interacted with each client type.

The data in Table 6 indicate that supervisors in the very active group, in contrast to those in the active group, interacted with a greater variety of clients. Thus, the very active supervisors did not limit their many activities to a few target groups but rather they conducted their dissemination activities with many types of clients.

Types of Dissemination Activities

The state science supervisors conducted a wide range of activities that are grouped into 12 types of activities in Table 7. Over half of the supervisors carried out some activities that involved providing information to clients through various means but without using Science Helper itself during the activity. The activities

Table 4

Types of Clients Involved in Dissemination Activities of State Science Supervisors

Types of Clients	Number of Supervisors Contacting Clients	Number of Dissemination Activities Involving Clients
Teachers	22	82
District Science Supervisors	16	91
College faculty	11	15
Project Staff or Participants	9	22
Principals	8	10
Regional Teacher Center Staff or Participants	8	10
State Science Supervisors, other states	8	12
State Science Supervisors, same state	6	11
Librarians	6	7
Curriculum Committees	3	4
Corporations	1	1
Scientists	1	1
State Legislators	1	1
Educational Technology Specialists	1	1

Table 5

Description of Client Types

Client Type	Description
Teachers	classroom teachers; school-based lead teachers with supervisory or resource role with other teachers
District Science Supervisors	individuals based at district office with responsibility for science curriculum for the district; some district supervisors responsible for other subjects as well
College Faculty	individuals at any post secondary institution with expertise in any area including education, science, and technology
Project Staff or Participants	supervisors referred to "projects" that were temporary endeavors (e.g., an NSF institute for improvement of elementary science instruction)
Principals	school administrators
Regional Teacher Center Staff or Participants	standing centers funded by state or multiple districts to meet inservice needs in science for a region of the state; some centers deal with additional subjects
State Science Supervisors, other states	state science supervisor at a department of education in another state (i.e., another study subject)
State Science Supervisors, same state	state science supervisor in the same department of education as the participant; occurred in states with more than one state science supervisor
Librarians	librarians at any library but usually school librarians
Curriculum Committees	supervisors referred to "curriculum committees" without specifying job titles of committee members or specific committee functions

Table 6

Comparison of Number of Client Types Between Active and Very Active Supervisors

Group	Number of Client Types	
	Range	Average
Active Supervisors	1-5	3.0
Very Active Supervisors	3-6	4.5

included making telephone calls, speaking with clients during meetings, writing information items in state science newsletters, and making overhead transparencies about Science Helper.

Almost half of the supervisors went to the effort of demonstrating Science Helper at scheduled meetings by getting on the program of either the annual science teachers' convention in their states or various types of workshops scheduled in their states. Several of the supervisors presenting at conventions also set-up Science Helper for continuous demonstration as an exhibit. Another popular place for demonstrations was in the supervisors' offices for visiting clients and colleagues.

Although only one quarter of the supervisors took Science Helper on the road for demonstrations to small groups of clients in their districts, this type of activity was the most frequent with a total of 55 reported events. This is because a few subjects essentially became itinerant salesmen who demonstrated Science Helper to many school districts, either at district offices or individual schools.

Table 7

Types of Dissemination Activities Conducted by State Science Supervisors

Types of Activities	Number Subjects	Number Activities	Example(s) of Activities
information only	19	36	presentation during meetings, writing notices in science education newsletters, making overhead transparencies
state convention	14	27	lectures, lecture demonstrations, demonstrations at booths in exhibition halls
workshop demonstration	13	22	lecture-demonstrations, simulations
office demonstration	10	43	demonstrations for visitors, training some visitors
district demonstration	9	55	taking system to districts and demonstrating
Science Helper loan	9	11	sending disc to others or permitting visitors to take it home
workshop training	7	27	training small groups of educators at workshops
lesson service	6	33	searching for and printing abstracts of lessons and/or actual lessons from Science Helper for clients
preservice training	3	3	training preservice teachers as part of college methods courses
technical assistance	2	5	giving installation or operating instructions over the telephone, visiting clients to assist with installation
grant proposal	1	1	requesting funds from corporation to disseminate Science Helper

Two types of activities that required a great amount of effort and time were training clients in the use of Science Helper and performing a lesson service for clients. In the former cases, supervisors set up Science Helper and then gave the clients hands-on training with it. In the latter cases, supervisors devised ways of responding to lesson requests from clients or even soliciting requests from them and then using Science Helper in the state office to find relevant lessons to mail out. Each of these two types of activities were carried out frequently by about one fifth of the supervisors.

There were two novel types of activities carried out by a single supervisor in each case. One supervisor wrote a successful grant proposal to a private corporation requesting funds to purchase a few portable computer systems and funds for travel so that Science Helper could be demonstrated at strategic locations around the state. Another supervisor expended state funds to buy Science Helper for five strategic school districts in the state.

The data in Table 8 indicate that the very active supervisors, when compared to supervisors in the active group, employed more types of activities. Thus, the very active supervisors used more diverse strategies for dissemination.

Patterns of Activity: Types of Activities versus Types of Clients

The data in Table 9 are arrayed to present a pattern of the state science supervisors' dissemination activities. Types of activities are listed in an order that is based on total numbers of occurrences with the most common one at the top and the least common at the bottom. The types of clients interacted with most frequently in the supervisors' actions are listed at the left; the types of clients that were less

Table 8

Comparison of Number of Activity Types Between Active and Very Active Supervisors

Group	Number of Activity Types	
	Range	Average
Active Supervisors	1–5	3.2
Very Active Supervisors	2–6	4.0

frequently involved are at the right. Two sums are given in each cell of the table: (a) The total number of activities conducted and (b) the total number of supervisors conducting the activity at least one time.

The dissemination event that was reported by more supervisors than any other was the demonstration of Science Helper at their state's convention for science teachers. The dissemination event that had the highest number of reported occurrences was demonstration of Science Helper to district science supervisors in their local districts.

Inspection of the table's columns indicates that a variety of activities were employed with each type of client. Data for the type(s) of activity most frequently conducted with a given type of client are underlined. Data across the table's rows show that each type of activity was used with diverse types of clients. Data for the type(s) of client most often involved in a given type of activity are in parentheses.

The data in Table 9 were compiled by summing the data from analogous matrices of data about each subject. Summative patterns for subsets of supervisors

Table 9

Patterns of Dissemination: Types of Activity Versus Types of Clients

Type of Activity	Teachers	District Science Supervisors	College Faculty	Projects
information only	5/5	8/7	2/2	2/1
state convention	(16/10)	2/2	1/1	---
workshop demo	(5/5)	2/2	1/1	(5/5)
office demo	(6/5)	(22/3)	0	0
district demo	12/3	(22/6)	2/1	4/1
S. Helper loan	0	(5/5)	4/4	0
workshop training	(14/6)	4/1	4/2	6/1
lesson service	(14/3)	(16/3)	0	0
preservice training	(3/3)	---	---	---
technical assistance	2/1	0	0	0
S. Helper purchase	0	(1/1)	0	0

X/X number activities/number supervisors conducting at least once

X/X underlined data: type of activity most frequently used with a given client type

Table 9 Continued

Patterns of Dissemination: Types of Activity Versus Types of Clients

Principals	Regional Teacher Centers	Other State, Sci. Supervisor	Same State, Sci. Supervisor	Librarians	Others
2/1	4/2	(13/6)	3/3	3/2	2/2
2/2	1/1	---	---	0	2/2
5/3	2/1	---	1/1	1/1	1/1
2/2	2/2	---	7/3	2/2	2/2
2/1	1/1	---	---	2/2	0
0	0	---	0	1/1	1/1
0	1/1	---	0	0	0
0	0	---	0	0	0
---	---	---	---	---	---
0	0	(4/3)	0	0	0
0	0	---	0	0	0

(X/X) Parentheses: type of client most frequently involved in a given type of activity

--- indicates no activity possible

were also compiled: Supervisors were grouped by type of state and also by job experience. No general differences in activity pattern were obtained when the supervisors were grouped by the type of state (i.e., primarily rural, rural with a few urban centers, and multiple urban centers). A difference was found in the activity patterns, however, when supervisors were grouped by their length of years on the job.

Supervisors with 2 to 6 years of experience were at the beginning of their career at the state level and were designated "new." Subjects with mid-range experience on the job, 8 to 17 years, were designated "continuing." Those state science supervisors with very extensive experience of 19 to 28 years of service were designated "veteran."

The groups of continuing and veteran subjects demonstrated Science Helper and trained clients in its use at more types of conventions and workshops than did new supervisors. New supervisors disseminated Science Helper almost exclusively at conventions and workshops for teachers. Continuing supervisors and veteran supervisors disseminated Science Helper at teacher events but also at events for all the other types of clients as well.

Sample Descriptions of Subjects' Activities

This subsection contains brief descriptions of two supervisors' dissemination activities to provide the reader with a more holistic understanding of the supervisors' actions. The data presented in tables thus far provided several ways of summarizing the supervisors' dissemination activities. However, these data were derived from stories that the supervisors told about their activities. Therefore, two histories are presented to help the reader understand the source data of this study.

The histories described here are merely two individual reports and cannot be considered as typical except in general ways because supervisors had varied sets of clients and dissemination actions. The total amount of activity carried out by these two state science supervisors was used to place one in the "active" group of supervisors and the other in the "very active" group. The first supervisors's actions illustrate that some supervisors had to overcome nagging obstacles to prepare for disseminating Science Helper. After solving these early problems the supervisor went on to conduct a wide variety of activities to disseminate the disc. The second supervisor made extensive use of a narrow set of dissemination activities to ensure that Science Helper was used in the state's school districts.

An active supervisor: A persistent strategist. Cynthia (a fictitious name) is characterized as a persistent strategist because she exerted considerable effort for many months to overcome problems while preparing to use Science Helper. She also carried out dissemination activities that were strategic in reaching key change agents in the state.

After Cynthia returned home from the training workshop, the next few months were spent overcoming obstacles to having a working Science Helper system. Having taken a CD-ROM player home from the workshop she set up a system but found that Science Helper would not operate. Several calls were made across the county to two different manufacturers as well as another science supervisor from the workshop to try and diagnose the problem. Cynthia received new software as a result of these phone consultations, but the system still did not work when this software was installed.

After further consultations Cynthia decided the next problem solving step was to get the equipment to a service center. This involved driving 90 minutes each way

to an authorized repair center plus waiting an hour for the service job to be done. The equipment worked at the repair center but did not function after Cynthia returned home. It turned out she needed to make a minor physical rearrangement of the component. She reported that "Anyway, after all of that it worked beautifully." All this was explained to the investigator 7 months after the training during a spontaneous conversation at a convention.

Once the problems in setting up Science Helper were solved, Cynthia carried a variety of dissemination activities. Four months after the training, she sent the investigator a copy of a grant proposal that was written to a private corporation in the her state. It requested funds to acquire equipment for three working Science Helper systems that would be used for doing live demonstrations around the state. The proposed plan was to work with faculty from a college of education as well as officers of the state's science teacher organization. Cynthia notified the investigator over 1 year later that the funds were awarded as a result of several contacts with the corporation during that period of time.

While waiting for the long-term plan of the funded proposal to materialize, Cynthia employed several other strategies to disseminate Science Helper. Six months after training she did a presentation of Science Helper at the annual meeting of the state science teachers association. A similar presentation was also done at the next year's meeting as well. In both cases Science Helper was demonstrated using curricular requests from the audience. Cynthia believed these presentations "were very effective," especially because members of the audience came up and tried the system after the session. She also arranged a presentation of the disc at the state's annual meeting for computer users in learning.

Another type of dissemination activity this active supervisor conducted was to speak with the directors of several of the state's regional teacher centers in support of their efforts to obtain and use Science Helper. Also, the disc was shown to several small groups of visitors in the supervisors' office. These visitors included district science supervisors, some teachers, and a few salesmen from publishers and educational supply companies. Cynthia wrote some information about Science Helper in a newsletter for the state's science teachers.

Cynthia also reported that "it gets some regular use in the office....I mean to me it's valuable because I'm in curriculum planning all the time, and I have a wide use for it." She went on to describe extensively two main curricular uses of the disc. First, the state was in the process of revising its curriculum objectives for science. Cynthia found the search system useful for discerning conceptual themes among lessons that could be related to major initiatives in curriculum reform that are presently taking place at the national level and in several prominent states. Second, the state department had a corporate grant to develop new science lessons that modelled conceptual approaches to curriculum. Science Helper was also useful in this activity.

Another use of the disc was to find possible activities for a science fair project. At the end of an interview, Cynthia requested suggestions from the investigator for looking up certain kinds of activities that might be suitable for her child to enter in a school science fair. While still on the telephone, Cynthia went ahead and used the system to obtain several lessons.

A very active subject: An aggressive apostle. Frank (a fictitious name) said, "I'm really, a real, well I'm an apostle of this thing, I think." It was an apt self-characterization because Frank was vigorous in carrying out dissemination activities

and was convinced of the usefulness of Science Helper. More than once he told the investigator that "the workshop was the most useful I've been to, bar none, in 15 years."

Frank returned from training and immediately perceived a role for Science Helper in the state's newly revised framework for science education. The framework attempted to cast the state's science curriculum in conceptual themes and processes that were consistent with similar concepts recommended in current reform initiatives at the national level. Science Helper's search system permitted users in this state to retrieve lessons using the state's guidelines in a way "that gave us a little bit more credibility to our work here in (state)." Frank developed a set of overhead transparencies that showed how Science Helper was useful for implementing the state framework.

Title II funds were used extensively by this supervisor for disseminating the disc. Title II funds, also known as Eisenhower funds, are provided by the federal government to enhance science and mathematics instruction in the states. District science supervisors from around the state who had responsibility for spending Title II funds were encouraged by Frank to spend them on Science Helper. He did this through telephone conversations and presentations at workshops that were being held to discuss use of Title II funds. As a result, over a dozen districts acquired systems, and Frank invested the time needed to go out to each of these district and train district supervisors and teachers on their own equipment.

This strategy was so successful that it was 15 months before Frank actually took the state's system out of the office. At this point, he began demonstrations for rural districts that had not been contacted as often and had not acquired a system. Frank also exhibited Science Helper at the state convention for science teachers.

Beyond Dissemination

Three supervisors took actions with Science Helper beyond direct interaction with clients to disseminate Science Helper; one of these supervisors, however, was an active disseminator as well. Their activities could be characterized as futurist. Two state science supervisors adapted Science Helper, and the third supervisor catalyzed legislation to foster Science Helper dissemination.

One science supervisor applied the search system in Science Helper to another curriculum project in the state. The system was used to catalog thousands of lessons that had been created by teachers in the state and compiled for distribution. Subsequently, individual state teachers could use the search system to rapidly find lessons that were appropriate to their specific needs.

Another supervisor also adapted Science Helper, building it into a larger system that became a multimedia tool for science instruction. The state already had interactive video for hands-on science instruction. Incorporating Science Helper permitted users to obtain lesson plans that were related to the instruction modelled on the video.

The third futurist worked with the state legislature to expand the definition of a textbook to include software and CD-ROM. This meant that districts could use textbook funds to acquire CD-ROM discs containing science lessons that were consistent with the state's curriculum guide.

Determinants of Dissemination

The third and final section of the results chapter consists of data that pertains to why the active and very active supervisors disseminated Science Helper and why the inactive supervisors did not disseminate. This general question of "why" was

addressed by the last three of the four research questions in the study: (2) What facets of their organizational environment and role influenced their actions? (3) What demographic and professional characteristics of the subjects affected their actions? (4) What characteristics of Science Helper influenced the supervisors' dissemination of it?

The factors influencing dissemination are listed in increasing order of influence. The curricular characteristics of Science Helper were the strongest influence on the supervisors's actions. Supervisors with the most professional experience tended to have the most positive perceptions of Science Helper's characteristics and conducted the most dissemination activity. Supervisors who commented on their role made statements indicating that Science Helper's curricular capabilities enhanced their role as curriculum consultants. The supervisors' workplaces had both deterring and facilitating effects on the supervisors' actions but did not have a decisive influence. Inactive supervisors generally praised Science Helper but also cited various factors that deterred them from disseminating it.

Working at the Department of Education

State science supervisors had partial autonomy in their departments of education to decide what tasks to undertake, and this authority permitted supervisors to disseminate Science Helper to whatever degree they elected. State science supervisors generally had many mandated functions but also had wide latitude to decide how to fulfill those functions and what their daily schedule should be. No supervisors reported that superiors or colleagues stopped or discouraged them from disseminating Science Helper. A few supervisors reported active support and encouragement from colleagues and superiors.

Bureaucratic processes in the states' departments of education were not conducive to innovations and hindered some supervisors in their efforts to obtain needed equipment. Forty percent of the supervisors reported difficulties purchasing Science Helper, particularly, problems with paperwork and authorizations. However, all supervisors reporting these problems overcame them and obtained equipment for use in disseminating the disc.

The multifaceted nature of the state supervisor's job meant that most supervisors found it difficult to attend to one specific task over a sustained period of time as was the case with dissemination of Science Helper. Although state science supervisors had considerable autonomy in deciding how to carry out their job functions, this freedom was constrained because most supervisors have more functions to perform than time permits. Many things vied for the supervisors' attention, and it was hard for them to sustain work on a specific task over a long period of time. Nevertheless, 83% of the supervisors did invest energy over many months to disseminate Science Helper.

Perceived Role of State Science Supervisors

Supervisors found dissemination of Science Helper to be consistent with and helpful to their role as state science supervisors. Some supervisors said that one aspect of their role was to provide clients with curriculum support. A few supervisors went on to state that dissemination of Science Helper helped them in this function and the same belief was inferred from the statements of a number of other supervisors. Several supervisors believed that having Science Helper to disseminate enhanced their credibility as supervisors.

Supervisors' Job Experience, Sex and Age

The amount of a supervisor's dissemination activity was examined for a relationship to selected professional and demographic characteristics. First, the extent of CD ROM dissemination activity was found to be related to a supervisor's length of job experience. Second, at first glance, sex and age also seemed to be related to the amount of their activity. However, a case is made from the data record that the relationships of activity to sex and age were not explanatory. That is, the distributions in the sex and age of the participants were related to length of job experience. State science supervisor positions go to people with experience and it was experience that influenced the amount of dissemination activity.

Chi-square analysis of the data in Table 10 ($p < .001$) supports the assertion that the amount of dissemination activity conducted by state science supervisors was related to their length of job experience. The numbers in each cell of Table 10 are number of supervisors observed (center number), the expected number of supervisors based on probability (upper-left number), and the square of the difference between observed and expected numbers of supervisors (lower-right number). All of the new state science supervisors were either active or very active (i.e., none of them were inactive). (Table 3 explained "inactive," "active," and "very active." "New," "continuing," and "veteran" were defined on page 55.) A disproportionate number of the continuing supervisors were inactive. All of the very active supervisors, except for one, were either new or veteran supervisors.

The supervisors' amount of dissemination activity was also examined for a relationship to both the sex and age of the supervisors. Significant chi-square results

Table 10

Contingency Table: Amount of Dissemination Activity Versus Length of Job Experience

Length of Job Experience	Amount of Dissemination Activity		
	Inactive 6	Active 20	Very Active 8
New 2-6 yrs. 13	2.3 0 5.3	7.6 10 5.8	3.1 3 .01
Continuing 8-17 yrs. 9	1.6 4 5.8	5.3 4 1.7	2.1 1 1.2
Veteran 19-28 yrs. 12	2.1 2 .01	7.1 6 1.21	2.8 4 1.44
Observed Chi-square			22.47
Expected Chi-square (4, .001)			18.46

were obtained for both variables in contingency tables comparing them with activity levels. The data on supervisors are categorized in Table 11 by amount of activity and by sex. The most notable finding from these data is that all of the very active supervisors were males (i.e., no females were very active subjects).

Table 12 lists the data on supervisors distributed by amount of dissemination activity and by age. The most notable finding is that almost all of the younger state

Table 11

Contingency Table: Amount of Dissemination Activity Versus Sex of Supervisors

Sex of Supervisors	Amount of Dissemination Activity		
	Inactive 6	Active 20	Very Active 8
Males 26	4.59 4 .35	15.3 14 1.69	6.12 8 3.5
Females 8	1.41 2 .35	4.7 6 1.69	1.88 0 3.5
Observed Chi-square			11.08
Expected Chi-square (2, .01)			9.21

science supervisors were in the active group (i.e., only 1 supervisor was in the inactive and very active groups). As was mentioned earlier, the relationship between both sex and age and the amount of activity were put into perspective by examining the distribution of these demographic characteristics with the supervisors' length of job experience. Table 13 shows the numbers of supervisors with different lengths of job experience grouped by sex and age. Comparison of the data in Table 13 to that of Tables 11 and 12 supports the assertion that it was the supervisors' job experience that influenced their amount of activity rather than their sex or age.

Table 12

Contingency Table: Amount of Dissemination Activity Versus Age of Supervisors

Age of Supervisors	Amount of Dissemination Activity		
	Inactive 6	Active 19	Very Active 8
40-49 12	2.18 1 1.39	6.91 10 9.55	2.91 1 3.65
50-59 14	2.55 3 .20	8.06 8 0	3.39 3 .15
60-69 7	1.27 2 .53	4.03 1 9.18	1.70 4 5.29
Observed Chi-square			29.94
Expected Chi-square (4, .001)			18.46

For example, it can be argued that the reason none of the female supervisors were in the very active group was because of their more limited experience (i.e., most of them were new supervisors, and none of them were veterans). Similarly, all of the very active supervisors were males because all the veteran supervisors were men.

The finding about age and activity can be interpreted in an analogous way. The reason that almost none of the subjects in their 40s were in the very active group

Table 13

Length of State Science Supervisors' Job Experience Grouped by Sex and Age

	Group	n	Length of Job Experience		
			New 2-6 yrs.	Continuing 8-17 yrs.	Veteran 19-28 yrs.
Sex	Males	27	8	7	12
	Females	8	6	2	0
Age	30-39	2	1	1	0
	40-49	13	9	3	1
	50-59	14	4	4	6
	60-69	6	0	1	5

is explained by their limited experience (i.e., most of the subjects in their 40s were new, and virtually none had the experience to be considered veterans).

Supervisors with more experience had stronger positive perceptions of Science Helper's curricular possibilities than did less experienced supervisors. These more positive perceptions may have been a factor contributing to higher activity levels.

Features of Science Helper

The data presented in this portion of the Chapter IV are the supervisors' comments about Science Helper's features. Discussion of these data will show that Science Helper's features influenced the supervisors' dissemination activities. The content of this subsection is (a) supervisors' descriptions of curricular features; (b)

supervisors' descriptions of the technical features; and (c) influence of perceived characteristics on the supervisors' dissemination of Science Helper.

Table 14 lists the features of Science Helper that were discussed by the supervisors. The investigator categorized these features as curricular or technical features. Other topics, discussed by the supervisors and also listed in table 14, were not statements of their perceptions of Science Helper but were related to the features of Science Helper: their clients' reactions to Science Helper and the availability of other CD-ROM discs.

More state science supervisors spoke about the curricular features of Science Helper than its technical features. Further, the amount of discussion about curricular features was 150% greater than the amount of discussion about technical features. The following discussion presents qualitative data which summarize and illustrate the state science supervisors' perceptions of features of Science Helper listed in Table 14. In the subsequent portion of the chapter, quantitative analysis of this descriptive data is used to argue that the subjects' perceptions of Science Helper's curricular features influenced their dissemination of the disc.

Description of curricular features. Almost all the state science supervisors who spoke about curricular features of Science Helper gave favorable comments. The supervisors perceived Science Helper to facilitate curriculum planning because it had strong advantages relative to existing curriculum planning using books, compatibility with their role as state science supervisors, and compatibility with their curriculum beliefs.

The curricular features discussed by the supervisors were (underlined words are used in Table 14) that Science Helper's lessons were produced by curriculum

Table 14

Number and Percentage of State Science Supervisors Discussing Science Helper's Features, and Amount of Discussion (N = 34)

Science Helper Feature	Number of Supervisors Discussing	Percentage of Supervisors Discussing	Amount of Discussion *
Curricular Features			
NSF curricula	22	65	231
search system	20	59	369
lessons	16	47	158
curriculum beliefs	14	42	265
average	18	53	256
Topics Related to Curricular Features			
client reaction	23	68	204
availability of other CD-ROM discs	11	32	102
Technical Features			
printing time	12	35	126
operation	11	32	128
computer compatibility	11	32	108
cost	8	24	47
average	11	32	102

* number of lines of typed data (e.g., number of typed lines in transcription of interview or conversation)

development projects funded by the National Science Foundation (i.e., the lessons were NSF curricula); Science Helper's search system enabled supervisors and their clients to find lessons that were appropriate to their needs; Science Helper contained many good lessons, and the curriculum planning made possible by Science Helper was consistent with the supervisors' curricular beliefs.

The data presented below describe and illustrate the supervisors' comments about these features. Other data that were related to the curricular features of Science Helper are also presented: client reactions to the curricular features of Science Helper and the availability of other CD-ROM discs.

Forty-seven percent of the state science supervisors praised the quantity and quality of lessons on the Science Helper disc in a general way. They spoke of the number of lessons available with words or phrases such as "huge," "vast," "a complete library," and "an incredible wealth of activities." Supervisors were pleased that the storage capacity of CD-ROM discs made so many lessons available. Examples of general words and phrases the subjects used to describe the quality of lessons were "tremendous," "beautiful," "fantastic," "excellent," and "conceptually sound."

Sixty-five percent of the subjects praised the quality of the lessons on Science Helper more specifically. They regarded the lessons as valuable because they were NSF curricula. Almost all of the many state science supervisors that commented on the NSF curricula made positive remarks about them and were favorably impressed with Science Helper because it consisted of them. A brief history of these curricula is provided in the following paragraph to help the reader understand the supervisors' comments about them.

During the 1960s and 1970s the National Science Foundation awarded approximately 80 million dollars in grants for development of new curricula in science education. Scientists teamed with educators to an extent that was and is still unprecedented for projects in science education. The curricula produced by these projects were innovative because their lessons illustrated basic science principles and facts in ways that were simple and understandable; the lessons were hands-on activities, and they highlighted scientific processes. Most of the NSF curricula were extensively tested in the classroom and numerous researchers found gains in student achievement and attitude when these activities were used rather than traditional curricula and commercial textbooks of the period (Brederman, 1982; Shymansky, Kyle, & Alport, 1983).

The NSF curricula were implemented by some teachers in virtually every state. However, most of the teachers in some regions did not use the new programs for a variety of reasons, for example, their districts did not adopt any of them; they lacked the skills or confidence to conduct the lessons; they believed there was insufficient instructional time given the back to basics demands, or they already had familiar traditional science curricula.

The state science supervisors regarded Science Helper to be valuable as an archive of the NSF curricula that had become difficult to obtain. Very few of the NSF curricula were readily available in the 80s before Science Helper was created. Some of the curriculum projects on Science Helper were never distributed by a commercial publisher, and others that had been published at one time were no longer in print. Thus, Science Helper contained more of the NSF curricula than state science

supervisors had access to previously. The following words of one supervisor illustrated this fact:

In other words, a complete library for those programs was available. I recognize that any of us may have bits or pieces of that library from the years past but it's unlikely that anyone would have the entire library available.

The supervisors were also pleased to have this archive of NSF curricula in the compact and durable form of the CD-ROM disc. One supervisors's succinct way of putting this was "to maintain an archive just takes so much space and collects so much dust, it's just not in this day and age an effective way to do it." A different supervisor that had collected many of the books found on Science Helper would probably agree with the previous statement. He kept them in the men's restroom because they took up so much space.

Science Helper's lessons from the 1960s and 1970s were perceived by many subjects to be relevant to the curriculum reform in science education in the 1980s and 1990s. The supervisors noted that some of the lessons' content was dated, and some current topics in science education curriculum were not present in the lessons. Nevertheless, the state science supervisors still valued the NSF curricula because they were hands-on activities that familiarized children with basic science facts and processes. These lesson characteristics are regarded as very important in the present reform in science education. One veteran supervisor spoke forcefully about the usefulness of the NSF curricula:

I never like to pay twice for the same real estate. I learned from the army, once you get some land hang on to it. And it's the same thing in curriculum development. There is absolutely no need for people to sit down and do curriculum development with a blank sheet of paper. You want to stand on the shoulders of giants. And I see those folks who created those NSF type programs, that they were well-meaning people. They were well-trained and they gave it the best shot at that point in time. You don't cut their work down

and say that was back in the 60s, that isn't any good, let's start from square one again because you know we have AIDS and drugs. You know, we can take what was there, and ask what can we still use? What has to be burned, and what has to be modified or enhanced?

New state science supervisors also believed the older NSF curricula had a contemporary role in science education and were glad that Science Helper permitted them to become familiar with these curricula. They had heard or read about the curricula but had not seen many of them before receiving Science Helper.

The extensive comments presented above were used by the investigator to illustrate the subjects' appraisal of the NSF curricula, but they were also a reflection of the supervisors' curriculum beliefs. Specifically, several state science supervisors said that existing curricula should be examined for their potential contribution to the current development of science curricula. Some supervisors expressed this belief using the phrase "Don't reinvent the wheel."

The state science supervisors indicated that Science Helper was consistent with other beliefs they held about curriculum as well. They valued hands-on activities in science instruction and perceived Science Helper to be a resource that made hands-on science more accessible, particularly for rural districts. Larger school districts typically have the financial wherewithal to supply a diversity of science curricula to teachers in the district. However, teachers in many rural and financially strapped districts have few books available for science instruction. Thus, the state science supervisors appreciated Science Helper because it was a huge resource of hands-on science lessons at a price that even rural districts could afford.

Science Helper was also valued by the supervisors because it could function as an alternative or supplement to existing curriculum programs. Several approaches

were usually found in the activities on the Science Helper disc for a given science topic. One supervisor illustrated this possibility as follows:

For instance, a fifth grade teacher is doing static electricity and is not happy with what that experiment looks like in the book. Or they wish there was a little twist to do something a little bit differently and really get students involved. So here's a way that they can just go in and supplement what's happening.

Several supervisors commented on Science Helper's value in providing a way to find lessons that correspond to state or national guidelines or frameworks for science education. The current reform movement for science education has led many national groups and state departments of education to develop new guidelines for science curriculum. Science Helper is designed to permit users to find lessons in ways that are consistent with these guidelines.

Several supervisors reported using Science Helper in the process of developing their states' guidelines. Other supervisors reported showing clients how to use Science Helper to find lessons that correspond to state or national guidelines. Several supervisors noted that Science Helper was useful for obtaining lessons that correspond to key aspects of Project 2061, a futurist curriculum framework being developed under the auspices of the American Association for the Advancement of Science (1990).

More than half of the state science supervisors spoke about the efficacy of Science Helper's search system. Further, there was a greater amount of discussion about Science Helper's search system than there was about any other feature of Science Helper. The design of Science Helper's search system allowed the subjects and their clients to go beyond selecting lessons only by topic. When selecting a lesson using Science Helper the search system also permits them to consider what science processes and themes of science should be incorporated in the lessons (see Figure 1). The

following comments made by one supervisor illustrate how strongly some of the them felt about the relative advantage of such a search feature:

Teachers can attach activities to curriculum in ways that they never could before....The idea of finding specific activities to do specific jobs is not within the capacity of teachers right now and they need to do that. And that (Science Helper) allows them to do that. That's very, very powerful. I think it's powerful to find and use the NSF activities but what it does to teacher's brains and heads and how they instruct kids is very different after using that than it is before. All of a sudden they know why they're doing the activity.... After they find it and they've searched it and it's their reason for having that (activity), they're a much better teacher.

Many other subjects made favorable comments about the kinds of curriculum planning made possible by Science Helper's search system. A few supervisors suggested refinements for the search system to enhance its capabilities.

The state science supervisors also liked the search system because it was easy and quick. Most supervisors found it quite easy to use Science Helper, even those with extremely limited experience with computers. Science Helper's speed made the supervisors more prone to carry out complex curriculum tasks. The supervisors viewed the time it took to look manually through books for lessons that illustrated a specific science process or conceptual theme to be prohibitive. In contrast, they were able to find lessons on specific science processes as well as particular topics and content themes in seconds or minutes using Science Helper.

Sixty-eight percent of the supervisors reported reactions of their clients to Science Helper. Virtually every supervisor that mentioned client reaction indicated that it was positive. The most conservative statements by the supervisors were that clients liked Science Helper or expressed a lot of interest in it. Stronger statements also were made, such as clients were "very, very happy with it," or "they were ecstatic

about what they got from it." The following quotation illustrates how positive some supervisors reported their clients' reactions to be:

It would just blow them away. I mean they would say "Oh my God, oh my God, look at this. I can't believe all this stuff exists. Look at this activity. Look at that activity." The teachers were amazed that there was so much information that they could use and what they like about it. It gave them the flexibility to pick and choose activities that could best meet the needs of their students.

Many subjects also reported that clients were implementing Science Helper (i.e., they were purchasing Science Helper and using it or at least expressing the interest or intent to do so).

Thirty-two percent of the state science supervisors spoke about the limited availability of other CD-ROM discs, and their perceptions of this issue were mixed. Science Helper was the first disc designed specifically for use in science education. The subjects looked at this situation in one of two ways that can be characterized by the classic discussion of whether the glass is half full or half empty. Some supervisors regarded Science Helper as a forerunner of things to come and were comfortable with that (i.e., this situation did not diminish their enthusiasm for disseminating Science Helper). However, the immediate lack of other discs for science education made other supervisors less enthusiastic about encouraging clients to obtain Science Helper and a CD-ROM reader to use it.

Description of technical features. Most of the state science supervisors who made comments on the technical features of Science Helper cited limitations in these features. They perceived Science Helper's printing speed and visual display (the the quality of images on the computer screen) to be a disadvantage relative to other computer software. They wished that Science Helper were compatible with all

computers. In terms of complexity, the supervisors generally perceived Science Helper as simple to operate but complicated to install.

The supervisors spoke about the following technical features of Science Helper (underlined words are used in Table 14): Science Helper's printing speed, Science Helper operation (i.e., the ease of learning the keyboard commands to execute Science Helper's functions as well as appraisal of the technical capabilities of Science Helper's functions), the computer compatibility of Science Helper with various types of computers, and the cost of Science Helper and CD-ROM readers. Data are presented below that describe and illustrate the supervisors' comments about these technical features of Science Helper.

The one-third of the supervisors who commented on the printing feature of Science Helper were all frustrated by its slow speed. Although the supervisors found that printing abstracts of lessons only took a few seconds they also found that printing each page of a lesson took several minutes. Most supervisors who mentioned slow printing regarded it as a serious inconvenience, but not one that would deter them from using Science Helper. Comments from three state science supervisors illustrate this concern:

The only complaint I have is the slowness of the print.

You got to really plan a long ways ahead of time if you want something in hardcopy. That is a problem but it's not insurmountable.

The printing capacity is real, real slow....So, suddenly this powerful thing suddenly limps a bit.

A few supervisors reported problems other than speed when printing lessons from Science Helper. Two of these supervisors found that lessons with many pages

overheated the printer, and a few other supervisors said that the computer would stop when printing so that they had to start Science Helper up again.

About a third of the supervisors spoke about the operation of Science Helper. Some supervisors commented on how easy it was to operate Science Helper, and others had criticisms about the operation of Science Helper. The following discussion is restricted to the keyboard operation of a working Science Helper system and does not include comments about the technical problems of installing Science Helper because those data were reported in the first section of Chapter IV.

Even some of the supervisors with limited computer experience perceived Science Helper to be easy to use, as the following comments from one of them illustrates:

Any dunderhead with a little bit of effort could make the thing work, and I'm positive proof of that. I said that before and I really do want to stress that again. Ya know, I am not a person who spends his life working on a computer. I use the computer because I have to and I think the use of CD-ROM has allowed me to do things that I couldn't have done otherwise.

There were other subjects who felt Science Helper was not easy to use. They made comments such as "It is a little bit fussy; You shouldn't have to have inservice to learn to use it."

Some state science supervisors mentioned flaws in Science Helper's programming. A couple of them reported instances where the system failed by bumping back to the beginning of the search system when they wanted to proceed further.

A few supervisors also recommended a technical change in the way Science Helper operates. Their suggestion was to store the information on Science Helper in ASCII; that would permit users to edit lessons when they found them. A couple of

supervisors pointed out that this type of storage would allow the lessons to be displayed on the computer screen in a more readable form as well. Finally, this storage format would make all lessons have the same appearance on the screen, and one subject expressed a preference for this over the current system that displays lessons in whatever way they appeared in their original book.

A third of the subjects were concerned that Science Helper did not work with all types of computers. Science Helper only worked with certain IBM-type computers during the time that data were collected for this study. Since the completion of this study, however, Science Helper has been updated to work with any IBM-type personal computer and all Macintosh computers. However, the state science supervisors often asked if their earlier version of Science Helper could be changed to operate with more computers.

Four state science supervisors were daunted by the cost of Science Helper (\$195) and CD-ROM readers (\$500-\$800), whereas four other supervisors commenting on this topic said those costs were either no problem or even an favorable aspect of Science Helper. Virtually all of the interested state science supervisors as well as their clients had to acquire a CD-ROM reader to operate Science Helper because it was their first CD-ROM disc (see the first subsection of Chapter IV entitled Obtaining CD-ROM Players).

The supervisors were usually more concerned about the impact of these costs on their clients than on themselves. One supervisor who viewed cost as an advantage said, "There's a lot of interest, especially when it comes to the cost and cost benefits." Another one of these supervisors said that "for a little bit of money you can really put all these activities in the hands of teachers." In contrast, a supervisor on the other side

of this issue said, "The cost of this technology is still above the means of 99% of our schools, and I still do not have my own CD-ROM player."

Influence of perceived characteristics of Science Helper on dissemination. The supervisors' positive perceptions of Science Helper's curricular features influenced them to disseminate Science Helper. Many supervisors held negative perceptions of Science Helper's technical features and had difficulties preparing to use Science Helper. However, these difficulties and negative perceptions did not deter 83% of the state science supervisors from being active or very active disseminators of Science Helper. This investigator concluded that it was the supervisors' strong positive perceptions of Science Helper's curricular features that influenced them to disseminate the disc despite limitations in its technical features and installation barriers in preparing to use it.

This conclusion is supported by the data in Table 14. More supervisors spoke about the curricular features of Science Helper than its technical features, with over half of the subjects discussing the former compared to a third of the subjects discussing the latter. Further, the average amount of discussion about curricular features was 150% greater than the amount of discussion about technical features. The state science supervisors also were influenced positively to disseminate Science Helper by their clients' perceptions of the disc. Over two thirds of the subjects reported that clients had favorable perceptions of Science Helper.

The amount of dissemination carried out by the state science supervisors was influenced by their perceptions of Science Helper's curricular features. In Table 15,

Table 15

Percentage of Supervisors Reporting Positive Perceptions of Science Helper's Curricular Features. Supervisors Grouped by Amount of Dissemination Activity.

Curricular Feature	Percentage of Supervisors		
	Inactive n = 6	Active n = 20	Very Active n = 8
NSF curricula	50	65	63
search system	33	55	75
lessons	33	35	63
curriculum beliefs	17	35	63
average	33	48	66

the dissemination activities of the inactive, active, and very active subjects were compared by using data about their perceptions of Science Helper. From these data it was concluded that the number of supervisors reporting positive perceptions of Science Helper's curricular features increased with their levels of activity. Two-thirds of the very active subjects reported positive perceptions, whereas only half of the active subjects and one-third of the inactive subjects reported positive perceptions.

In Table 16, data on all subjects' perceptions of Science Helper are summarized using four of the five perceived characteristics advocated by Rogers (1983). Overall, the state science supervisors' comments indicated the following perceptions of Science Helper: positive perceptions of relative advantages, positive perceptions of compatibility, mixed perceptions of complexity and trialability (i.e., some positive and

Table 16

Perceived Characteristics of Science Helper: Relative Advantage, Compatibility, Complexity, and Trialability

Perceived Characteristic	Net Perception	Net Influence	Specific Perceptions of Science Helper	
			Curricular Features	Technical Features
relative advantage	positive	strong	<u>advantage</u> more lessons quality lessons rare, valuable lessons faster lesson selection new ways of selecting enhanced role as curriculum consultant	<u>advantage</u> less space than books <u>disadvantage</u> slower printing inferior visual display
compatibility	positive	strong	<u>compatible</u> with curriculum frameworks, state, national with beliefs: hands-on science not reinventing wheel <u>incompatible</u> some contemporary criteria for lessons	<u>incompatible</u> doesn't work on all computers
complexity	mixed	weak	<u>simple</u> concept of searching easy to understand	<u>simple</u> operation of Science Helper <u>complex</u> installation of CD-ROM and Science Helper
trialability	mixed	weak	<u>acceptable</u> other discs available <u>limited</u> few other CD-ROM discs	<u>acceptable</u> cost of disc and reader <u>limited</u> cost of disc and reader

some negative perceptions). Relative advantages and compatibility strongly influenced state science supervisors to disseminate Science Helper. Although the supervisors did have mixed perceptions of complexity and trialability, these attributes were less influential. These findings are consistent with earlier studies in which the effects of these attributes on dissemination were examined (Clinton, 1973; Hahn, 1974; Holloway, 1977). Observability, the concept defined by Rogers as the degree to which the results of an innovation are visible to others, did not seem to be applicable to dissemination. The studies cited above found observability, in contrast to the other four attributes, to be a less-developed concept; they also did not find observability to be useful for explaining or predicting dissemination of the innovations studied.

Reasons for Inactivity

Four of the six inactive state science supervisors gave specific reasons why they had not disseminated Science Helper. One supervisor acquired equipment to operate Science Helper but was unable to get it working despite numerous attempts to do so that even involved consultations with other state science supervisors. Another supervisor had intended to disseminate Science Helper but did not because schools did not have CD-ROM readers.

Two state science supervisors said that innovations other than Science Helper prevented them from having time to disseminate it. One state was completely restructuring its entire education system, and the state science supervisor had to attend to the science education portion of that effort. Another supervisor was working with scientists over many months to develop a new curriculum.

Two of the inactive supervisors did not give as clear reasons for their inactivity. One supervisor was a "late bloomer" who had just obtained equipment and got it working by the end of the data collection period for this study, which was 20 months after receiving Science Helper. This state science supervisor expressed an intent to disseminate Science Helper but did not offer an explanation for the long period of inactivity.

The other supervisor did not give a reason for not disseminating Science Helper, but this supervisor did make statements from which an explanation can be inferred. The supervisor said that the content of Science Helper's lessons did not include some topics that were state-mandated. Therefore, Science Helper could not be considered for adoption as a textbook in the state. This supervisor did not speak of the possibility of using Science Helper as a supplement in the state's curriculum as it was in all the states where it was disseminated.

Summary

The study results were presented in three sections: (a) Preparation for Dissemination, (b) Dissemination Activity, and (c) Determinants of Dissemination. Data in the first section documented that state science supervisors invested the time, money, and energy to obtain and install equipment for using Science Helper: Eighty-six percent of the subjects obtained CD-ROM readers with 75% purchasing them, and 50% of the supervisors reported difficulties they had to overcome when setting the equipment up.

Section two of Chapter IV described the state science supervisors' dissemination activities. Eighty-three percent of the state science supervisors

conducted a total of 268 dissemination activities, using 12 types of activities with 14 types of clients. Twenty subjects were categorized as "active" (3–9 activities), eight were "very active" (13–44 activities), and only six were "inactive" (0–2 activities). All state science supervisors in rural states were active or very active.

The most common dissemination activities were providing information about Science Helper or demonstrating it at conventions and workshops. The most common clients were district science supervisors and teachers. The group of very active subjects had the widest variety of clients and activities. Three supervisors went beyond dissemination: two adapted Science Helper to state needs, and one catalyzed legislation to facilitate adoption of CD-ROM discs with textbook funds. Brief histories are provided of the dissemination activities of two state science supervisors: one active subject and one very active subject.

Data in the third section of Chapter IV pertain to why the state science supervisors disseminated Science Helper (i.e., the determinants of dissemination). Amount of activity was related to length of job experience using a chi-square contingency table ($p < 0.001$): All new supervisors were active or very active; four of the six inactive subjects were "continuing" state science supervisors, those with 8–17 years experience; most veteran supervisors, 18 or more years experience, were either active or very active.

The state science supervisors' perceptions of Science Helper's features strongly influenced dissemination. The subjects' comments about Science Helper's curricular and technical features are described and quoted extensively in this final section of Chapter IV.

State science supervisors were positively influenced by the curricular features of Science Helper: quality, quantity, and origin of its lessons (NSF-sponsored); power and relevance of the search system to the needs of their clients; and compatibility with subjects' curriculum beliefs. Two technical features of Science Helper, printing capability and computer compatibility, were generally perceived negatively. Individual subjects either had positive or negative perceptions of two other technical features, cost and operation of Science Helper.

However, positive perceptions of curricular features generally overshadowed negative perceptions related to technical features. The amount of discourse about curricular features was approximately twice the amount of discourse about technical features. Further, amount of dissemination activity was related to the frequency of perceptions of the curricular features: sixty-six percent of very active supervisors and 48% of the supervisors in the active group spoke about the curricular features but only 33% of the inactive supervisors addressed the curricular aspects.

In summary, the state science supervisors perceived relative advantages for Science Helper and found it compatible with their curriculum beliefs and their role as curriculum providers. Their perceptions of its complexity and trialability were mixed. The influence of these attributes, however, was overshadowed by that of perceptions of the curricular features.

CHAPTER V SUMMARY, CONCLUSIONS, IMPLICATIONS

Summary

This study investigated state science supervisors' dissemination activities related to a new technology. Activities of state science supervisors have rarely been studied, even though these supervisors have positions that inherently give them the opportunity to be influential change agents. The innovation studied, a CD-ROM disc called Science Helper, provides new capabilities for curriculum planning in science education. This study furthers understanding of dissemination, an area of research that is being re-invigorated with federal support in connection with current national and state reform agendas in science education.

The purpose of this study was to determine what actions were taken by 35 state science supervisors, following a training experience, to disseminate Science Helper. This CD-ROM disc, the first to facilitate lesson planning in science education, contained nearly 1,000 science lessons originally developed and tested in the 1970s. The researcher also investigated some determinants of the supervisors' actions. Thus, two topics in this study have rarely been investigated before: (1) A new technology with curricular implications, and (2) state science supervisors' dissemination activities.

Three areas of literature were consulted to inform the study: science supervisors' roles, CD-ROM in education, and dissemination of innovations. The few previous investigations of science supervisors' roles indicated both supervisors and their clients believe an important supervisory function is to provide curriculum resources to clients (There only have been two studies of science supervisors as a special category of professionals). Dozens of articles in academic and trade journals have described CD-ROM technology and its first uses in education. However, this study of the dissemination of Science Helper was the first research investigation of any aspect of the impact of CD-ROM in science education.

Previous research on the diffusion of educational innovations found that characteristics of adopters and their perceptions of innovation characteristics are major determinants of innovation acceptance. Several prior studies found five perceived attributes of innovations to be useful for explaining acceptance of innovations: relative advantage, compatibility, complexity, trialability and observability. Findings in this study were organized in terms of these five perceived attributes of innovations.

A case study design was employed in which the dissemination of Science Helper by the 35 state science supervisors was considered a single case. The case was studied using two levels of analysis: individual subjects and across subjects. Four kinds of data were collected over 21 months: Interviews were conducted with every supervisor; secondary data sources were conversations, correspondence, and electronic communication. After transcription, data were analyzed using a constant

comparative method. Computer software was used for the mechanics of coding and sorting data.

Eighty-six percent of the state science supervisors invested time and money to obtain CD-ROM readers to operate Science Helper. For 50% of the supervisors, this preparation was labor-intensive due to technical obstacles (e.g., getting the system installed and running) and bureaucratic problems (e.g., paperwork for purchasing a novel piece of equipment). Eighty-three percent of the supervisors conducted a total of 268 dissemination activities using 12 types of activities with 14 types of clients. The most common activities were providing information and conducting demonstrations at workshops or conventions. The most common clients were district science supervisors and teachers. Amount of activity was related to length of job experience in an unexpected way: all "new" supervisors were active, most of the "veteran" supervisors were active, but a disproportionate number of the less active subjects were "continuing" supervisors, those with 8-17 years experience.

The state science supervisors disseminated Science Helper because they perceived the curricular features of Science Helper to have strong relative advantages: quality, quantity, and origin of lessons (NSF-sponsored); power and relevance of the search system to their own needs and those of their clients, and compatibility with the subjects' curriculum beliefs. Science Helper facilitated their role as curriculum providers. Two technical features of Science Helper were generally perceived negatively: printing speed and limited computer compatibility. Individual subjects had either positive or negative perceptions of the cost and

operation of Science Helper. Positive perceptions of curricular features generally overshadowed negative perceptions of technical features.

Conclusions

The data in this study support three conclusions related to the three aspects of improving science education discussed in the study rationale: (a) state science supervisors will actively disseminate innovations when they perceive the innovation's characteristics to have relative advantages, and dissemination of the innovation is consistent with their role; (b) Science Helper was perceived to have strong relative advantages for curriculum planning; and (c) relative advantage, compatibility, complexity, and trialability were useful attributes for explaining why the supervisors disseminated Science Helper.

State science supervisors have positions that give them the opportunity to be influential change agents. However, there are many demands upon their time and bureaucratic obstacles to functioning this way, some of which were documented in this study. Despite this, an overwhelming majority of supervisors did disseminate Science Helper. The supervisors' perceptions of the relative advantages of Science Helper's curricular features influenced them to act. Further, they perceived the dissemination of Science Helper to be compatible with their role as curriculum providers, a supervisory function that also was important to science supervisors and their clients in previous studies (Dowling & Yager, 1983; Madrazo & Hounshell, 1987; Madrazo & Motz, 1983; Trueblood et al., 1979).

Science Helper was perceived to be a valuable curricular tool providing new capabilities for lesson-planning. It had several relative advantages over the

resources traditionally available to elementary teachers: a huge number of quality lessons and a search system that permits users to rapidly find lessons appropriate to their curricular needs. The state science supervisors perceived the Science Helper CD-ROM disc to fit the definition of an innovation (i.e., a change or something new). The investigator characterizes Science Helper as a curricular tool: It represents both a new technology and a new curricular resource that together create new modes of lesson planning, namely, rapid access to multiple lessons which serve a user-selected purpose.

This investigation confirmed the usefulness of four perceived attributes of innovations that were characterized and investigated by previous dissemination studies in education (Clinton, 1973; Dozier, 1985; Hahn, 1974; Holloway, 1977; Rogers, 1983): relative advantage, compatibility, complexity, and trialability. The investigator found the general attributes above useful for organizing the specific features of Science Helper discussed by the subjects. Further, their influence on dissemination generally was the same as their influence as reported in the prior studies.

Implications

Policy Recommendations

Policy-makers and the science education community should consider disseminating innovations in part through state science supervisors. Supervisors may be active disseminators when they perceive innovations to have relative advantages and the dissemination of them to be consistent with supervisory role of curriculum provider. It is important to determine if the supervisors perceive each

innovation this way because time demands could preclude them from disseminating a host of innovations that might not rate as high priority in terms of their functions. The workshop held to familiarize the state science supervisors with Science Helper was a fruitful investment by the National Science Foundation. The Foundation and other federal agencies or departments with a science education mission should consider ways to regularly familiarize supervisors with relevant innovations.

Federal efforts should be made to encourage states to maintain or improve the position of state science supervisor. The current recession is forcing many state agencies to reduce personnel. It is clear from this investigation that state science supervisors are potent agents for dissemination of new innovations; they see such activity as a prime function. To close out the positions in the interest of saving money just when so much leadership and help is needed would be to retard the progress of the country toward the year 2000.

A chance finding of this study was that all science supervisors in rural states were active disseminators. The data collected made it possible to make this conclusion but no data were obtained to determine why this was the case. However, it could be speculated that state science supervisors in rural states believe a particularly strong obligation to be curriculum providers because there are fewer district science supervisors to help with dissemination in their states. If they do not spread the word, there is no one else to do it.

Development of more CD-ROM discs for curriculum planning in science education should be considered. Many curricular features of Science Helper were universally embraced by the state science supervisors and their clients. Additional

discs should also be useful, especially if some of the cumbersome technical features could be improved which should be possible given the rapid progression of CD-ROM technology.

Further Research

Studying the impact of state science supervisors' dissemination activities would help policy makers to further gauge the effectiveness of using these supervisors to implement innovations. The supervisors' actions to promote awareness and understanding of Science Helper, documented in this study, were a necessary first step toward implementing Science Helper. However, resources were not available for the researcher to investigate what impact the supervisors' activities had on their clients. Future studies on the dissemination of innovations by state science supervisors could explore which clients obtain the innovation and how they use it.

Further research on the role of state science supervisors would be useful to the science education community. Because little formal study of these change agents has taken place, there are numerous possible topics for investigation. Policy-makers might be interested in both qualitative and quantitative description of state science supervisors' activities and clients. Also, it has been some years since a determination of the status of this job position in the state agencies has been conducted, or of the professional background of state science supervisors (Dowling & Yager, 1983). Similar studies on other subject-area supervisors at the state level (e.g., mathematics, language arts, etc.) also could be of interest to state

and federal leaders; scant research about these other subject-area specialists was located in a brief inspection of the literature.

Because the number of CD-ROM products is increasing rapidly, it may be valuable to further learn how these resources shape state-level curriculum planning and dissemination activities. This study provides a baseline on perceptions of CD-ROM discs and the spread of this curricular tool. Future studies could investigate perceptions of other discs, not only to determine if and how they are disseminated but also what influence their existence may have on state-level curriculum planning.

Beyond the state level, research is needed about Science Helper's impact on classroom teachers. Such studies could use adaptations of the questions from this investigation (e.g., How do teachers perceive the characteristics of Science Helper, and how do these perceptions influence their use of Science Helper?). What curriculum tasks do they use Science Helper for and under what conditions? An intriguing investigation could be examining in detail how teachers use the search system. The system has some features which are designed to influence, over time, the curriculum planning of teachers.

Further understanding of dissemination in contexts where the content and technology for access are so wedded could increase the efficiency of introducing such innovations to the science education community. In this study, the attributes of relative advantage and compatability were used to retrospectively explain the dissemination of Science Helper. This research was valuable because less than 1% of dissemination studies have examined how perceived characteristics of

innovations affect their adoption or dissemination. In addition to pursuing more of this research, investigators could approach the use of these attributes to predict the adoption and dissemination of innovations. Rogers stated this possibility in his 1983 compilation and analysis of dissemination research:

The latter type of research can be of great value to change agents seeking to predict the reactions of their clients to an innovation, and perhaps to modify certain of these reactions by the way they name and position an innovation and relate the new idea to existing beliefs. (p. 211)

APPENDIX

INTERVIEW PROTOCOL AND QUESTIONS

A. Familiarize supervisors with interview conditions.

1. Thank you for participation
2. State study purpose
3. Explain procedures for subject anonymity
4. Commitment to share study results
5. State researcher neutrality toward innovation
6. Explain interview format; conversation with guiding questions

B. Have conversation with guiding questions.

Although all questions were asked of each supervisor, the conversational interview format resulted in a varying order and wording of them.

1. What experiences have you had with Science Helper since your training?

Probes for identifying types of clients, types of activities.

2. What changes would you like to recommend in the training you received with Science Helper?
3. What changes would you like to see in the design or operation of Science Helper?

Question four was only asked if supervisors were active in disseminating Science Helper.

4. What are the characteristics of Science Helper that encouraged you to see a potential role for it in your state?

C. Responsive Questions

Questions were often asked to clarify subject statements. Researcher also pursued topics that were initiated by the supervisors during the conversation when they were germane to the study purpose.

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BIOGRAPHICAL SKETCH

Edward D. Britton was born in Toronto, Canada, and spent his elementary and middle school years there. He moved to Florida in 1968 with his parents and graduated from Clearwater High School in 1972. St. Petersburg Junior College awarded him an Associate in Arts degree in 1973. From 1973–1977, he attended the University of Florida for the first time and graduated from an A.C.S. and N.C.A.T.E. certified program with a Bachelor of Science degree in chemistry. During 1977–1981, Mr. Britton was a classroom teacher and science department chair at the Keystone Heights Jr.–Sr. High School in Florida.

Mr. Britton returned to the chemistry department at the University of Florida in 1981. He conducted a thesis in analytical chemistry using tandem mass spectrometry to identify marker substances in samples derived from petroleum deposits. After receiving a Master in Science degree in 1985, he entered the doctoral program for science education in the College of Education at the University of Florida. Mr. Britton became a grant manager for Dr. Mary Budd Rowe in 1986 and coordinated two major projects and several smaller ones until 1991.

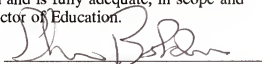
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Mary Budd Rowe, Chair
Professor of Instruction and
Curriculum

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Patricia Ashton
Professor of Foundations of Education

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Elroy Bolduc
Professor of Instruction and
Curriculum

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This dissertation was submitted to the Graduate Faculty of the College of Education and to the Graduate School and was accepted as partial fulfillment of the requirements for the degree of Doctor of Education.

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